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THE 200-VOLT LAMP QUESTION.

PROBABLY the most prominent question before supply engineers at the present moment is that of doubling the voltage on low pressure systems. It arises from a laudable desire of engineers to make the most of the systems which they control. Whoever can supply two lamps when only one was supplied before deserves encouragement. We do not claim to be original when we say that the doubling of pressure on many supply circuits is of immense importance. Its adoption means in some cases the difference between success and failure; the carrying capacity of existing mains is at once doubled, and the area of supply can be increased to twice its former size. This is accomplished with very little effort; in some works a mere rearrangement of machinery will suffice, but in few cases will the cost of conversion prove an obstacle. Few doubt the wisdom of this change. For our own part we think the experiment will achieve so much success, that we may fairly doubt whether doubling the pressure will satisfy the more energetic of our supply engineers; they may soon desire to go further. As low pressure systems consist, for the most part, of mains laid on the three-wire method, with a difference between the two outside mains of 200 volts, we immediately get under the new scheme 400 volts difference. Shall we stop there? If it is shown that 200-volt lamps can be used in buildings with perfect safety, will it be too much to aspire to a 300-volt lamp. The Board of Trade will not object to such a voltage in the interior of houses, but when this is attained there will be a difference in our street mains, providing a three-wire system is still maintained, of 600 volts. What, then, becomes of low tension and *ergo* of low tension advocates? As sensible men they will move with the times, and who shall blame them for their want of constancy. But, however desirable the proposed change may be, it is a matter in which we should hasten slowly. The time is scarcely ripe for changes of a wholesale nature, and it is incumbent upon engineers to be cautious in dealing with this question. We urge caution for two reasons. The first is, that much of the wiring in existence is, under all circumstances, in a highly dangerous state; and the second is, that for some time, at any rate, there will be difficulty in securing large quantities of 200-volt lamps. Perhaps the first of these reasons is the more serious one. There is not the slightest doubt that a good deal of inferior wiring would go clean out of existence if 200 volts were sent through it, but this passing

away might be followed by consequences which, for the well being of electric lighting, are best avoided. There are many houses that need to be put in order before an undertaking would be justified in supplying electrical energy at a pressure of 200 volts. The responsibilities of the supply engineers are greater, and though there has been previously a disposition towards a winking acquaintance with bad work, it is very evident that 200 volts will call for a very high standard of wiring. On many systems the change to the higher pressure will be a gradual one, for after all the consumer must be allowed a voice in the matter. He may raise real or fancied objections to having 200 volts about his house, or he may have a system of wiring which, though tolerably safe for a 100-volt service, would be quite unsuitable for twice that pressure. Yet, to suggest that such a consumer should have his premises re-wired is obviously asking too much. It is clear that one result of a 200-volt supply will be to increase the cost of wiring, even assuming the conductors be smaller. It is the insulation, and not the copper that would tell under such circumstances. This aspect of the question is not an unimportant one, and is deserving of some thought.

There is another very good reason why central station engineers should move slowly in this matter. It would be of very little use to change a system from a low pressure to a higher one, unless there is an abundance of 200-volt lamps in the market. From careful inquiries that have been made amongst lamp makers, we are inclined to think that a large supply does not exist, and, indeed, some time must elapse before a reasonable demand could be met. No doubt there is a fair number of 200-volt lamps actually in use; but if everybody wants them at the same time, it is very likely that a deadlock will result. In asking for these higher voltage lamps, some amount of latitude must be given to the makers. They ought to know their own capabilites of manufacture better than central station engineers, and it will not be wise to ask for lamps which must comply with specifications that are drawn up regardless of manufacturing necessities. Lamp makers have not yet finished experimenting, and it seems to us that they are more likely to evolve a suitable lamp, if they are not interfered with from the outside. We are not disposed to accept the double filament lamp as the pattern for the future. To depend on such is to rely on a broken reed. It may serve as a stopgap to meet present needs, but it is obvious that the only practical lamp will be that of one filament. The placing of two filaments in series must tend to increase the weakness of a lamp. Nor must the increased cost be omitted from one's calculation. During the last two or three years we have been much exercised in educating the public up to the point of using cheap and short-lived lamps, must we go back on that idea, and, in a mild way, stultify ourselves? No doubt when the manufacturers have gained experience, the cost of production will be cheapened; but it is clear that with the increase of material in a double filament lamp it will be difficult to sell it at the present price of 100-volt lamps. From a consumer's point of view, therefore, there are two objections at the outset: the increased cost of wiring, and the enhanced price of lamps.

The making of 200-volt lamps, too, involves some difficulty. The operators will be obliged to handle double the voltage that was previously required. Some of the operations will necessitate the use of four and five hundred volts, and in pumping and flashing there is more liability to accident than hitherto existed. With adequate precautions there ought not to be an increase in the number of accidents, but the extra care involved will mean that lamps cannot be turned out so quickly, and that alone would materially increase the cost. One difficulty, we believe, the makers feel very much is the restriction in the size of bulb. If a bulb, the size of a Jersey pear, were permitted, the making of a filament having the necessary resistance would be comparatively easy, but we cannot depart from the elegant shape of the present 100-volt lamp. The space between the conductors of the lamp at a difference of potential of 200 volts is so much, that a larger sized bulb would be almost imperative. But we are afraid the public will prove inexorable, and the manufacturer will be obliged to seek his salvation in another way.

It seems to us that, having regard to much of the present wiring that exists, the trouble in securing lamps, and their enhanced price when obtained, engineers would do well to most carefully consider the matter. We are not saying that they will find sufficient to deter them from going forward—indeed, we should be sorry if they did—but the proposed change is a great and radical one, and we want them to see all round the question.

Electrical Tanning.

SINCE 1850 many attempts, chiefly of an empyrical nature have been made to accelerate the process of tanning by means of the electric current; and, during the past few years, we have often had occasion to notice and sometimes to criticise the more recent and more scientific efforts which have been made in the same direction. Amongst these the system which has become identified with the name of Groth is, perhaps, the most entitled to consideration, though, according to Folsing, this system is but an improvement on that of Worms and Balé. In order to accelerate the Groth system, which has undoubtedly met with a measure of success, Folsing has recently suggested the use of extracts such as those of fir, quebracho, oak, &c., in place of the usual oak bark, these extracts having been previously purified, cleared and decolourised. He claims that this small modification will materially hasten the Worms and Balé process, which takes 48—144 hours for thin skins, as well as the Groth process, which may take as much as three months in the case of heavy ox-hides. Folsing has also elaborated a further improved process suitable either for the tanning of thin or for thick hides, and which only requires from three to six days for the manufacture of the raw material into leather. Briefly, it is as follows, though a full account may be found in the *Electrotechnik und Elektrochemie* ii., pp. 167—171:—The tanning pit has a capacity of 15,000 litres and is about 2 metres deep, 2 metres broad, and 3 metres long. Electrodes of nickelled copper are fixed to the longer walls of the pit, and in the latter the hides are so suspended that the current has to pass right through them. A current of 12 ampères with an electromotive force of 12 volts is used. The tanning matter consists of oak extract with a little hemlock extract added, both of which are cleared and decolourised by a special electrolytic process. By these means Folsing states he succeeded in obtaining good leather in 72 hours from light cow-hides, in 5 days from heavy cow-hides, and in 6 days from heavy ox-hides. The ox-hides would require a year's treatment by the old process.

THE HISTORY OF A GREAT ELECTRICAL COMPANY.

(*Concluded from page* 596.)

At the present date, some 15,000 H.P. is expended in supplying Berlin with electric light and power from four large central stations. The demand for electric energy continues to increase at so rapid a rate that additional plant of several thousand horse-power is to be immediately laid down. It has been recognised, however, that this makeshift policy is not likely to answer much longer, and the A. E. G. have, consequently, worked out a comprehensive scheme which is intended to meet all future requirements of Berlin in the way of electric light and power, and to supply the electric energy at a price with which no other form of light and power will be able to compete. The following are some particulars obtained from Herr Rathenau, concerning the grand scheme by which this millenium is to be brought about.

The whole of the electric energy to be supplied to Berlin will be generated in one gigantic central station to be built on the upper part of Spree, about 9½ miles from the city. The station will cover an area of 25,442 square metres. The engines will be capable of developing a maximum of 60,000 H.P. This will be made up of two units of 1,000 H.P. each, two units of 2,500 H.P. each, four units of 5,000 H.P. each, and three units of 10,000 H.P. each, making together a total of 60,000 H.P. The three-phase system of distribution is to be adopted. Herr Rathenau considers that the three-phase motor, owing to its simplicity and the absence of brushes, is specially adapted for small motive power, for which there is a considerable demand in Berlin. It is considered that about 30,000 H.P. will be required for street railways, and the other 30,000 H.P. for lighting and other purposes. The current will be supplied from the main generating station to the present central stations, where it will be transformed and converted and distributed through the existing networks. Other transforming sub-stations will be erected where required.

The current will be supplied to sub-stations near the central station at 5,000 volts, and to more distant sub-stations at 10,000 volts. This high voltage current will be conveyed into the city by bare overhead conductors, but supported on suitable insulators, every precaution being taken to prevent accidents. Herr Rathenau says they have proved by experiment that currents of 15,000 volts can be safely carried in this way. It is expected that from this great central station they will be able also to supply to small towns in the neighbourhood of Berlin, electric energy at wholesale prices. The local authorities will themselves carry out the distribution to the consumers. The electric energy can be supplied to them from a large central station over very considerable distances, at much less cost than they can produce it themselves.

The present price of the kilowatt hour in Berlin is 7·2 pence (60 pf.). Large discounts, however, are given according to the amount of current taken, and the time during which it is used. This discount amounts, in many cases, to 50 per cent. for lighting, so that the kilowatt hour may often cost only 3·6 pence. For power the discount is still greater, and near the central stations the unit can be obtained for 1·9 pence (16 pf.) When the great central station has been erected, it is intended to supply the kilowatt-hour to the electric tramways at 1·2 pence (10 pf.) and still give discount according to the quantity of current used. Electric energy will be supplied to places more remote from the new central station at still lower rates. An effective horse-power will cost only ·6 pence (5 pf.) per hour and the kilowatt-hour ·72 pence (6 pf.)

Herr Rathenau considers that it is quite feasible to supply London with electric energy at the same or even less prices than those that are proposed for Berlin. Coal, no doubt, is cheaper in London than in Berlin, and if the site of the electric generating station be fixed at a sufficient distance from London the land could be got cheap. The site would be near a wharf or railway coal depôt. Herr Rathenau estimates that 200,000 H.P. would be necessary to supply London. None of the present networks would be disturbed. A three-phase alternating current would be supplied at a tension of 10,000 volts, by overhead wires, to the present central stations, where it could be transformed or converted into continuous current as required for each system. Herr Rathenau would undertake to supply the electricity to these stations cheaper than they could possibly produce it themselves. The cost of labour at these sub-stations would, of course, be much reduced. With electric energy supplied at such low prices, as Herr Rathenau says, no form of light or power could compete. The consequences which would follow the carrying out of such a scheme can scarcely be overestimated, and this scheme is not merely the dream of an amateur, but has been declared to be perfectly practicable by one of the greatest authorities on the carrying out of installations on a great scale.

Herr Rathenau considers that if a large station were erected in the neighbourhood of London sufficient to supply the whole of the great city, that the heat required for raising steam might be obtained as a bye-product from coke ovens, gas retorts, or some such manufacture by which the products of the distillation of the coal could be sold for a price that would cover the cost of the fuel. In such an enormous central station as would be required for London, he would have at least four large engines of 30,000 to 40,000 H.P., the rest of the 200,000 H.P. being made up of smaller units.

To a question as to the type of engine he preferred for central stations, Herr Rathenau said that depended on several factors, such as the price of coal in the locality and the number of hours a day the engines were working full power. These factors vary considerably for different localities and different kinds of work. For example: for lighting, the supply is required, on an average, only 2 hours a day, for electric tramways, on the contrary, it is used on an average 16 hours a day. Where coal is cheap and where the machinery is working only a few hours out of the 24, then it is a mistake to erect very expensive engines with all the latest improvements to obtain the maximum horse-power from the pound of coal per hour. Conversely, of course, when coal is expensive and the machinery has to work long hours a day, it is important that engines of the highest efficiency should be used. Herr Rathenau considers that this principle of minimum cost of production has not been sufficiently attended to by English electrical engineers, and that the failure of some of our large central stations has been due to this neglect.

In reply to a question about the installation at Niagara, Herr Rathenau said, the slow alternations were a mistake, because they were not suited for electric lighting. The three-phase system, which they are to adopt at Berlin, he considered was the best. As to the price at which it has been stated that electricity is to be supplied at Niagara, namely, ⅛d. per H.P. per hour, he said that they already supply it at that price at the Rhinefalls installation, where 1 H.P. is supplied for a year at £4. He advises consumers, however, to pay for their electric energy by the meter, and not by the horse-power for a given time, since in the first case they pay only for what they use, while in the second case they pay for the maximum rate of supply for the whole time.

COST OF STEAM POWER.

(*Concluded from page* 610.)

Having considered the cost of continuously generated steam, the results are calculated on the basis of variable power.

The first case assumed is as follows:—

1.	20,000	H.P.	10 hours a day	=	200,000	H.P. hours daily.
2.	12,000	„	10 „	=	120,000	„ „
3.	5,000	„	4 „	=	20,000	„ „
			Total ...	...	340,000	„ „

This for 309 days annually, gives 105,060 million H.P. hours, to which, for the remaining 56 days of 24 hours, is added a call for 5,000 H.P., giving a total of 111,780 million H.P. hours, gives an average of 12,760 H.P. per hour the year through, an amount equal to 63·80 per cent. of the maximum, or, as Dr. Emery terms it, the power factor.

In working out the cost, it is clear that 15,000 H.P. of boilers, out of 20,000, must be daily shut down, and an hour's consumption of coal is assumed for banking and bringing to working condition again, &c. Hence the total H.P. hours per day are increased by 15,000, and multiplied by 309, and added to the 56 days' horse-power, to find the cost, which is then worked out on a basis of 1·25 lb. of coal per H.P., and multiplied by 1 mill. per pound, with a twelfth for friction. The result is the yearly coal cost of $157,644, being 37·3 per cent. of total cost. Labour is 11·3 per cent., or $47,652, being at the rate of $0·00027 per horse-power, and $13,140 for superintendence, the labour being allowed a surplus of 20 per cent. for the 14 hours of reduced power per day. The two show 78·83 per cent. of the cost of labour and superintendence required for full operation. Similarly, supplies and repairs are taken as 70 per cent. of the full power demand, and form 17·4 per cent. of the cost., the remaining 34 per cent. being for interest and taxes, &c., as before, or $144,000. The final results are $33·14 per horse-power per annum. Adding 5 per cent. on original cost of plant for dividend, and $1 for general expenses, gives a cost of $37·74, and if 10 per cent. be the assumed dividend, the cost will be similarly $41·34, or very nearly 16 per cent. above the cost of a continuously generated power, which was $35·54.

The three costs thus found become $15·17, $19·52, and $23·12 respectively for the case of power generation 10 hours daily for 309 days, and for half the holidays, or a total of 3,370 hours per year, but only $0·75 is now added for general expenses. The 10 hours' day dispenses with two assistants, so reducing superintendence to $9,000 a year. Supplies and repairs are reckoned at 0·6 mill. per horse-power hour, and taxes, &c., as before, for as the plant will last longer, there will be more additions on the score of improvements to swamp the saving in renewals.

In Dr. Emery's paper for 1893, with coal at $2·27 per ton and 10 hours a day, a horse-power year was worked out at $22·31. The cost per year was thus almost exactly 10 times the cost of a ton of coal, which may be compared with the present estimates, which show a saving of between 15 and 16 per cent. for generation on a large scale.

It is pointed out that, in comparing water-power costs, the items represented by interest, insurance taxes and renewals, ought to be added to the bare cost of water-power to cover the user's own plant which he has laid down to utilise the water which he pays for. The head and tail gates may cost as much as steam plant, if well done. Similarly in electrical power, corresponding additions need to be made to the mere cost of current.

These considerations are always omitted from popular discussions of the subject. If omitted from the case of the 10 hours basis, the cost of a horse-power would thus be only $7·89. It is particularly important to remember these points. In fact, the cost of labour, coal supplies, and repairs, is about half the real cost of power, and is not even three-fourths when the running is continuous and uniform.

DEVELOPMENT OF THE ELECTRO-DEPOSITION OF GOLD IN THE TRANSVAAL.

By EMILE ANDREOLI.

The Siemens-Halske process for the electro-deposition of gold from cyanide of potassium has been described and discussed in several numbers of the Electrical Review, and while criticising certain points of this application of electrolysis, the importance and value of the new departure was fully recognised. The progress realised since last year has been enormous, and the following figures and facts which we find in the recently published report of the Rand Central Ore Reduction Company, Limited, will no doubt excite the surprise of many, even amongst the most enthusiastic partisans of electro-chemistry.

The Worcester plant was started in May, 1894, and has since regularly treated 3,000 tons per month.

The success obtained in these works was followed by its introduction at the Metropolitan Gold Mining Company upon joint account, and the Metropolitan Company has since bought from the Rand Central Ore Reduction Company the plant, which has now a capacity of about 5,000 tons per month, and commenced operations in November last, since which time it has treated 26,909 tons of tailings, and produced 4,845 ounces of gold.

The May Consolidated plant, being the third erected by the Rand Central Ore Reduction Company on the Siemens system, started work in May, and is now treating 6,000 tons per month. The extraction is about 80 per cent., and the working costs 2s. 4d. per ton, excluding a royalty at 3 per cent. This plant is using the system of double treatment of its sands.

For the Crœsus Gold Mining Company, the Rand Central Ore Reduction built the fourth Siemens plant of a capacity of 6,000 tons per month; this plant has just completed its first clean-up.

The General Works of the Rand Central Ore Company have also installed the Siemens process.

Plants now Using the Siemens Process.

Name.	Capacity. Tons.	Average per month. Ounces.
Worcester	3,000	700
Metropolitan	4,500	600
May Consolidated	6,000	1,000
Crœsus Gold Mining Company ...	6,000	500
No. 4 Central Works	5,000	800
Robinson Slime Plant	8,000	...

Companies who have Decided to Use the Siemens Process.

Name.	Capacity. Tons.
Simmer & Jack	8,000
Van Ryn Estate	8,000
Van Ryn West	8,000
Crown Reef Slime Plant	8,000

Many difficulties of all sorts were met and superseded by the energetic representatives of the Siemens-Halske firm, and the results obtained so rapidly, and on such a large scale, were so encouraging, that the electro-deposition of gold is developing very fast everywhere in the cyanide of potassium districts, and supplanting the so defective zinc-shavings process.

When the clean up takes place, the lead cathodes on which the gold has been deposited are withdrawn from the tanks, and are cupelled in furnaces, where the recovery of gold is effected under the supervision of Mr. Jones, a skilled Swansea refiner.

Mr. Charles Butters, the managing director of the works, who wrote the report, seems to have resented the remark made, that the amount of gold in solution leaving the boxes is rather large. His reply, which is very sensible and just, is that the test of any process is its ability to precipitate the very dilute cyanide solutions obtained in the treatment of slimes. Successful slime treatment to-day is only possible by means of the use of the Siemens process, to precipitate the gold from the dilute liquors without the loss of cyanide. Absolute precipitation of the gold contained is merely a question of the right box capacity to give sufficient circulation to the solution, and expose it long enough to the action of the current.

Experience gives the following result:—

With a box, inside 30 feet long, 4 feet 7½ inches wide, and 9 feet high, containing 121 plates of steel, 4 feet 6 inches × 3 feet × $\frac{3}{16}$ths inch as anodes, and having as cathodes 120 frames containing four sheets of lead each (4 feet × 2 feet), (480 sheets containing 8 square feet each = 480 × 8 = 3,840 square feet lead; each plate weighs 22 ounces); they can precipitate 50 tons of solution per day from 2 dwts. of gold to a trace only per ton.

For the treatment of 100 tons per 24 hours in 1894, the capacity of the four tanks was 2,560 cubic feet; for the treatment of 50 tons during the same time in 1895, one box only is used, with a capacity of 1,248 feet.

The surface of cathodes is 3,840 feet, but the two sides of the cathodes make it 7,680 square feet for one 50 tons tank, and 15,360 square feet for 100 tons.

The anodes are the weak point of the Siemens process. The report says that the iron anodes are estimated to *stand five years*.

Mr. Van Gernet last year told us that the loss of iron was 1,080 lbs. per month; there are 60 months in five years; that would make 64,800 lbs., say, 32 tons of iron. It is presumable that the anodes would not work very well after the second or third year, and when the anodes are sick the liquid is worse; it does not work, and the deposition of gold is far from being what it should be.

The problem in the electro deposition of gold lies in finding an anode which will not be attacked, corroded, and disintegrated with formation of noxious by-products which decompose the cyanide solution.

Better results will be obtained when iron anodes give place to a better material which will make an insoluble anode. The information as to the rate of circulation is, that the solution travels a distance of 120 feet by 8 feet = 960 feet, by circulating round each plate, and goes through this distance in 14½ hours, the box holding about 30 tons of solution; the speed of flow is equal to about 1 foot per minute. This shows that 29 hours are necessary for the treatment of 60 tons.

We are not told whether the gold electrolyte is exhausted. This is not immaterial, but exhaustion has never been thought of. When the electro deposition process has been worked for a little time, improvements will be introduced, and the precipitation may be perfected, so as to reach the ideal, *i.e.*, the complete precipitation of the gold while its solution passes through the tanks. For the present, we must content ourselves with what we have. Instead of the zinc precipitation boxes, which do not take more than 75 per cent. of the gold of the cyanide of potassium solution, and which yield an impure gold, we have an electrolytic process which gives about the same recovery of, say, 65 to 70, or even 75 per cent. of pure golds, as Mr. Butters says, after having declared that the probability is that the working capacity of the boxes will be gradually increased; in fact, 50 per cent. more solution can be safely put through a box in 24 hours if it is not necessary to have complete precipitation. This is only required by the final washes. We can safely infer from this that the liquid, when leaving the tanks, contains still something like one-third of the gold it contained when entering them. If there was any doubt about it, the following extract from the report would dispel it.

Mr. John R. Williams, consulting metallurgist to the Crown Reef Gold Mining Company, in investigating the capacity of the precipitation boxes for his company for use in their new slime plant, obtained the results shown hereafter in a table with a tank containing 56 plates of the size as above, from the treatment of 24 tons in 24 hours, in the central station works of the Central Rand Ore Reduction Company:—

No. of test.	Time.	Originals 2 dwt. 12 gr. After precipitation.	·005 per cent. K. Cy. Strength of cyanide.
1	3 hours	1 dwt. 4 gr.	·004 per cent. K. Cy.
2	6 „	20 „	... ...
3	9 „	12 „	... ...
4	12 „	8 „	·004 per cent.
5	15 „	4 „	... ...
6	18 „	2 „	·004 per cent.
7	21 „	less than ½	... ...
8	24 „	0 gr.	·004 per cent.

These results would have been much more striking in the case of the Siemens process if the experiments had been made under the same conditions as in the usual daily work at the rate of 100 tons of solution per day.

As a matter of fact we are not told, we do not know exactly, how much gold is extracted from the 100 tons solution which is electrolysed. We are not supplied with a table as above, showing the gold before and the gold after treatment. No electrical data are given.

With regard to the strength of cyanide of potassium, if such a word may be applied to an almost infinitesimal proportion of cyanide of potassium, we reserve our opinion.

The capacity of the tank was 24 tons; the liquor was running at the rate of 1 ton per hour. At the end of 24 hours the liquor was exhausted; the number of plates was 56 instead of 120, but the circulation was four times as slow. It would not be fair to argue on the possible meagreness of the yield of gold extracted by the Siemens process; however imperfect it may be, it is possible it will be improved; but such as it is, we must consider it as an immense progress in the gold industry. What we must take as granted is what Mr. Butters says, that the Worcester works, where the Siemens process was at first introduced, are under the immediate direction of the assistant manager, Mr. A. Van Gernet, late of Siemens & Halske, and that these works have the credit of making an ounce of gold at the lowest cost of any of the plants of the Central Rand Ore Reduction Company. These Worcester works have continued to be a constant source of experience, and have made at the same time a handsome profit, which cannot always be said of the first plant built to exploit a new process.

THE LIMITS OF ELECTRIC POWER TRANSMISSION.

That there is a very general impression as to the possibility of transmitting electric power many hundreds of miles with economy is certain, and to combat this idea the *Engineering Magazine* prints an article by Mr. Alton D. Adams, who states that data are really wanting as to the cost of a horse-power per year when transmitted electrically. While long distance work is attractive from the scientific standpoint, before it can be made at all common it will be necessary to show that commercially, also, it has the germ of success, and so far as cities are concerned, the problem resolves itself into one of competition with the stored energy, capable of being carried, locked up in a coal car. This is undoubtedly the case. Energy stored in a fly-wheel or in a cylinder of hot water, or in a secondary battery, is the form of stored energy which appeals to most electricians, but all these forms are pigmies when compared with that stored in a lump of coal. Even with engines using 20 lbs. of steam per H.P. hour, the energy, which can be utilised, of a piece of coal, would lift it to a height of nearly 200 miles above the earth's surface, or draw it against the resistance of an ordinary railway for a horizontal distance of about 40,000 miles. Against such a competition as this it is obvious that the losses upon a long electrical line ought to be very small, while the cost of the line itself must be as so much dead load. In order to approximate a comparison it is assumed that $20 per H.P. is a low price for generators, motors, and transformers, that 81 per cent. of the brake power of an engine can be delivered by the motor apart from line losses, or say 73 per cent. with transformers. Thus, if we wish to deliver 1,000 H.P. at a point 25 miles distant, and we use a pressure of 10,000 volts and allow a line loss of 10 per cent., we must supply a 1,520 H.P. engine The generator will deliver 1,397 H.P. The sum of 1,000 and 1,397 is 2,397, double which for the transformers is 4,794, which at $20 per H.P. is $95,880. The $20 per H.P. being evidently reckoned upon each horse-power of electrical machinery whether this be a dynamo, a transformer, or a motor. In this instance there is, of course, a dynamo and a step-up transformer at one end of the line and at the other end a step-down transformer and a motor, so that for an engine of 1,520 H.P. there is a total of 4,794 H.P. of electrical machinery involved in the manufacture and delivery of a net 1,000 H.P. Now to transmit 1,000 H.P. at the above voltage for 100 miles at a 10 per cent. loss, with copper at 12 cents per pound, implies $400 per mile, or $10,000 for 25 miles, and the total plant cost per H.P. sums up:—

Machinery	95·88
Wire	20·00
Poles, &c.	10·00
Accessories	1·00
	$126.88

On this there is allowed 5 per cent for depreciation and repairs, 3 for operating expenses, and 10 for interest and dividends, or a total of 18 per cent., or 22·83 per H.P. for cost of transmission alone; but with good steam plant and coal at $2.00 or $3.00, the cost of steam power is only $25 per H.P. year of 3,120 hours, and $45 per H.P. year of 7,300 hours, so that under ordinary conditions of 10 hours days the power must be delivered absolutely free to the electrical generators in order to compete on a 25 miles line. For 365 days of 20 hours about $20 per H.P. year may be allowed for the cost of power delivered by motor, and, as shown, 1·52 H.P. must be

generated for each H.P. delivered. Hence the maximum cost of power delivered to the generator must not exceed $13.33 per H.P. year. Since with free fuel steam power will cost $25 per H.P. year of 365 days of 20 hours, so transmitted steam power is out of the question in the above case. Water power at some points can be had for $13.33 per H.P. year, so that with water power there is a commercial prospect of success on the 20 hours day, all which, however, seems to show that the commercial radius is much less than popularly supposed, though if alternating generators and motors at 10,000 volts can be had, or continuous current machines placed in series, to use such a voltage then, with the saving of the transformations, there may be numerous cases up to 25, or even 50, miles over which payable transmission might be extended. The author, however, does not overlook that there are numerous special cases, as in the case of a mountain mine, where the cost of steam power is excessive; and transmission schemes may be carried out at even larger cost than indicated, and, again, current may be delivered direct to customers, and the cost of motors at the receiving station thereby saved. This, of course, could equally well be done by a generating station near at hand using coal conveyed energy. Too much weight ought not, perhaps, to be placed on our author's next argument as to reliability, the once stock argument against electric lighting. It will probably become as useless against power transmission as it now is against ordinary lighting. At the same time, the fact cannot be gainsaid that lighting owes its success to duplication and underground wiring safe from the element of wind. Our author is not generally favourable to what we may term the wholesale transmission of power other than that by the coal car, but he does not enter into the æsthetic question at all. After all, so far as the electrical engineer is concerned, the only question is in respect of the length of line and the land value for generating station. The machinery will be much the same in amount whether the generating station for London be in Wales or at the Welsh Harp. In one case there would be more line, in the other a longer coal carriage. But we might point out that electrical transmission will be possible where the means for conveying coal are absent, and such may, before long, be the case, to a considerable extent, in South Africa, or, generally in Africa where there would appear to be a good deal of water power.

As a set-off against the not too hopeful views of this article, we might set the statements of fact by Dr. Louis Bell in the concurrent issue of the rival magazine of *Cassier*. Dr. Bell points out numerous successful instances of power transmission, and also has an eye on other phases of the question which tend to a more hopeful view of long distance work.

For ourselves, we are much inclined to doubt whether the final comparison will be made with steam power at all, and that the figures will be derived from what the near future shows possible with gas power.

THE ISAR WATER-POWER STATION.*

By OSCAR VON MILLER.

Just above Munich, where the River Isar breaks through the "Nagelfluh" mountain, a large water-power station has been established by Herr Heilmann for the purpose of supplying electric light and power to the suburbs and outskirts of Munich. The works were designed and carried out under the superintendence of Messrs. Widmann & Telorac, of Kempten.

The raised weir, which is constructed of cement concrete, is built up on piles, and on the left bank of the river is situated the sluices, &c., leading into the canal to the power station. The canal, with a sill width of 26 metres and a depth of 2·6 metres, yields 64 cubic metres of water per second.

At a distance of 800 metres below the weir is situated the first turbine station, comprising a turbine house for four turbines, a bye-pass and a tail race. As the useful fall here amounts to 3·6 metres, and the normal volume of water to 55 cubic metres per second, the available water-power reaches 2,000 H.P.; but under unfavourable water conditions the power at disposal is reduced to approximately 1,500 H.P.

The canal is arranged so that a second and third turbine installation can be erected at some future period, thus bringing up to 6,000 H.P. the power which will be available for the Isar works. At present, however, only the first installation, which is equipped with plant to the extent of 1,000 H.P., is in operation.

The power house contains two Jonval turbines of 500 H.P., made by the Augsburg Maschinenfabrik. These turbines have worked well, and even during the severe winter in 1894-95, no interruption took place in the operation of the machines. The regulation of the turbines is obtained, on the one hand, by means of sector valves, which allow of a good efficiency being realised, even at times when the volume of water is small; and, on the other, by means of ring flood-gates arranged at the water exit from the turbines, and permitting of a very quick regulation of the speed being accomplished by hand.

It was not considered advisable to adopt automatic regulators, as, with the low fall available, the ordinary regulating mechanism for electric light installations does not ensure sufficient evenness or equality with large variations in the load; whilst brake regulators, which fulfil this condition, are too noisy, and are subject to heavy wear. Thus, instead of employing automatic regulating appliances, provision was made for the introduction of an electric resistance, which, during the hours of low consumption of current, and when the variations in the lighting on the insertion of motors was mostly noticeable, simultaneously loaded the electrical plant and the turbines. A compensating resistance of this kind, whose consumption of energy is of no consideration in water-power installations, is the best for preventing the unpleasant pressure variations in electric lighting.

The electrical plant, which, together with the transformers, was furnished by Messrs. Brown, Boveri & Co., is driven by simple toothed transmitting gear, and at 105 revolutions per minute, the output is 350 kilowatts, with an E.M.F. of 5,000 volts. These generators are so constructed, that they can yield 350 kilowatts when 66 per cent. of this output is employed for motor work, whose difference in phase corresponds to a relation of from 1 to 1·2 between actual and apparent watts.

The long distance, extending over 15 kilometres, to which the transmission of current is made, necessitated the employment of high pressure alternating current. Of the various alternating current systems, preference was given to the three-phase or rotary current method, because, as compared with two-phase current, a smaller number of wires is required, and because the rotary current, as against the single-phase current, which yet admits of the use of fewer wires, permits of electric motors being readily started, this being of advantage in the case of factory working, as is the case in connection with the Isar station.

The switchboard, which was made by Messrs. Voigt and Häffner, was arranged according to the designs of the author, and the general arrangement is so simple, that the station service can be looked after by the turbine attendants. As in the case of the turbines, so in regard to the electrical plant, no special automatic apparatus has been introduced, this being all the more possible, by reason of the fact that the loss in pressure in the generators between running empty and at full load, only amounts to 5 per cent. On the extension of the installation it will be possible to entirely separate the motors from the lighting part of the station, in case the pressure of the current for lighting purposes on the connection of rolling mills or other industries, with specially large changes in the load, should vary too much, notwithstanding the compensating resistance.

The current from the Isar station leaves the switchboard, and is transmitted a distance of 9 kilometres to Thalkirchen and Obersendling, and will subsequently be extended to Laim, Gern, and the other suburbs of Munich. The long distance circuit now consists of three copper conductors, each 8 mm. in diameter, and fixed to wooden masts by means of the ordinary triple mantle insulators.

The stepping down of the 5,000-volt current to 110 volts is effected by ordinary alternating current in relation to rotary current transformers. The installation of rectifiers and accumulators, which are of advantage in many cases

* Abstract from the *Elektrotechnische Zeitschrift*, November 7th, 1895.

where the water-power at disposal is inconsiderable, was out of the question for the Isar works, as the latter have available, for an indefinite period, sufficiently large powers without its being necessary to use batteries for storage purposes. Separate transformers are installed in those factories where large motors are used; but for small powers, and for lighting, transformer chambers are provided at suitable points. These transformer stations are fitted with cutting-out devices on both the high and the low tension mains, so that the network can be divided, and any portions separated from it at will.

The low pressure mains, which form a completely closed network, are carried through all the streets of the localities served. Thus, where there are no large motors in operation, or expected to be installed, only two conductors, which are connected to one of the three current phases, are put up. In the case of small motors, both those of single phase and rotary current are used, but for large powers, rotary current motors only are employed.

Although the Isar station has not been long in operation, and as it only as yet supplies a small suburb of Munich, the number of lamps connected amounts to 2,500 of 16 C.P., and of electric motors to 30, ranging from ¼ H.P. to 25 H.P. The motors are used both by large and small works, and as the station is debarred from furnishing a supply of electric light and power in Munich, the efforts now being made to induce manufacturers to remove their works from that town to outside are being successful. The first move in this direction is to Sendling, where not only is electric light and power available, but also cheap land, plenty of water and fuel, and direct connection with the main line of railway by means of sidings.

CURIOUS ACTION FOR DAMAGES.

On October 14th the New Jersey Supreme Court, at Trenton, gave a decision in favour of the plaintiffs in a suit against a street railway company for damage from an electric shock due to improper bonding of rails. The suit was brought by Samuel M. Bennett and Charles S. Cooper against the Trenton Passenger Railway Company. On May 27th, 1894, while the plaintiffs were out driving behind a valuable horse, the animal happened to get his hind legs on a rail and received a shock which caused him to become unmanageable; both men as a consequence were thrown out and Mr. Bennett was severely injured.

The evidence, summarised by the *Electrical World*, showed that the rails were bonded with a single No. 2 iron wire, the supplementary return being No. 4 iron wire; the former is equal to a No. 9 copper wire.

Measurements made in May, 1895, for difference of potential between rail and ground, 4 feet away, showed under the normal operation of the road at times, one and one-half volts. The inference was that with the conditions as they were at the time the horse was shocked, there could have been a difference of potential sufficient to cause the accident. Experiments made on horses showed that they jumped at 4·5 volts, direct current. Witnesses were produced to prove that at several other times horses had been shocked and knocked down at this same place, but the Court overruled this testimony.

Prof. Moore, of Princeton College, testified that he had measured the resistance of the track and found it ·62 ohm per mile. This he considered very low. In rebuttal, Mr. Woodbridge, of New York, testified that he had made track measurements, and found ·03 ohm, which he considered rather high. Prof. Moore's figure, according to an expert for the plaintiff, is equivalent to a drop of 250 volts per mile of track with 400 ampères. Prof. Moore also produced a model to prove that it was easier to get a shock on a dry day than on a wet day. He had a tin pan connected to one side of a magneto, and a piece of iron connected to the other side, resting on some dry sand in the pan. When jurymen touched the pan and iron they received a shock, but on wetting the sand the shock ceased. Prof. Moore refused to submit to a new set of conditions, as proposed by the experts for the plaintiffs, and he was duly scored by counsel in summing up, the experiment as he arranged it being declared to be comparable to a horse having one foot on the rail and the other on the trolley wire. The judge charged the jury as to the law in the case, and after being out several hours, they brought in a verdict in favour of the plaintiffs, naming damages.

THE CONTROL OF TRANSFORMER LOSSES ON CONVERTING SYSTEMS OF ELECTRICAL SUPPLY.

By JAMES WHITCHER, A.I.E.E.

(Concluded from page 602.)

Under either condition, the curve exhibiting the relation between the E.M.F. across the outer mains of the three-wire system, and the sub-station load, is of the "sine-secant" order (y, $\propto$, sine, x, $\propto$, secant), closely approximate to $A = 2B\sqrt{(l - b^2/d^2)}$:—B and b constant. The constant losses of the large elements, A, should be due to hysteresis chiefly, and therefore proportional to the 1·6th power of E; whence it will be represented by the curve,

$$L = K(2B\sqrt{1 - b^2/a^2})^{1\cdot6}.$$

The load or copper loss varies as $(d^2 - b^2)$; hence its curve is a parabola convex to the axis of d.

At fig. 9 are plotted these curves, along with one showing the losses added, and a similar set giving the losses of a converting plant controlled by a multiple graded system of cut-

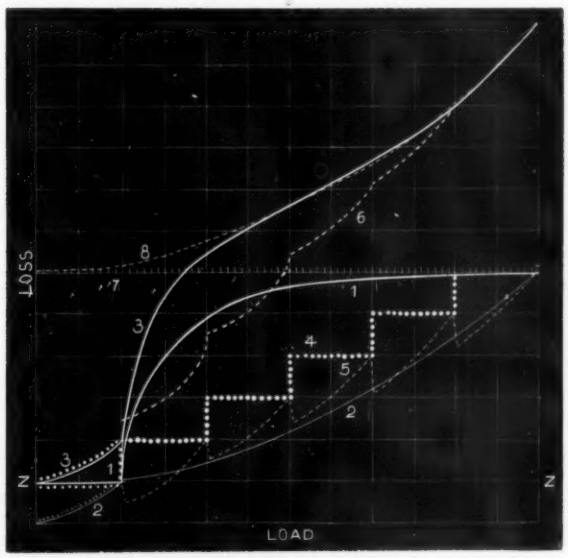


Fig. 9.

ting out members. And there is also a pair of curves exhibiting the losses of the same plant when uncontrolled. This figure is of general interest, since it proves what has already been remarked, that there is little or nothing to be gained by following up the slopes of a load curve, especially beyond half-load. It is only on low lying flats, or long easy inclines, that appreciable saving can result. The line, z, z, represents both copper and iron losses of the small elements of the transforming unit, and curves 1 and 2 above are the total iron and copper losses for the whole unit. No. 3 is their sum. The stepped curves, 4, 5, 6, are corresponding diagrams for a plant of six members, brought successively into action; and 7 and 8 are the iron and total losses of the same all active. The fact that 3 rises so soon to coincidence with 8 is due to the small elements being, in this case, given too much duty; it can be brought below to a certain minimum curve, but this need not be entered into. Curve 6 is better, but it could only be attained by hand regulation.

It seems, then, that continuous and multiple grade methods have scarcely more than a theoretical interest; their chief value is in the adjustment they allow at low load, removing

the arbitrary limit for change-over, which the simple systems must follow. I have described the modification rather as an interesting development of phasal methods in electro-technics, applicable for exceptional cases of the purpose in view, and probably for other purposes of greater importance.

As regards the generating plant, there are a variety of methods of producing the varying phase difference. For one, a duplex alternator, with either the shaft coupling or the field rings, capable of angular adjustment over a suitable arc while running. Or bi-phase alternators in parallel may feed each circuit through a rotary field transformer and multi-point switch. Obviously a few steps would be as serviceable as the continuous adjustment of phase, and, given a bi-phased current, it is a simple economical matter to combine them in apparatus on the principle of the equaliser to obtain these steps.

Before leaving the subject, some reference should be made to its bearing in the simple house transformer system. Here the evil effect of the constant losses on the cyclic efficiency is greatly aggravated by the smallness of the transformers, and the very poor load factor at which they are worked. Unfortunately, however, the scope for control is limited, practically, to two indifferent methods. One is to employ a sectional transformer, with an automatic switch, to change-over the connections from parallel to series, or *vice versâ*. The second comprises an automatic switch on the primary side, signalled to act by a relay in the secondary circuit, the signalling current, when the primary is broken, being provided by a battery or a miniature transformer. These methods are necessarily complex; a better resource, from one point of view, is to put the meter on the primary side, with a convenient switch, and a notice to the consumer that he will save some 50 per cent. by turning it off when no current is required.

The magnitude of the waste may be realised when one notes that there are types of small transformers with 5 per cent. iron loss, and the average load factor is probably 20, these figures giving a cyclic efficiency of about 46 per cent. In such an instance, it would no doubt pay to expend £10 extra per kilowatt for better transformers, or £4 or £5 for an automatic controlling gear.

The iron losses may be attacked by varying the frequency, doubling which reduces them by about one-third; but this is rather an argument for the constant use of the highest frequency the plant in general is capable of.

EUROPEAN INCANDESCENT LAMPS.

[Communicated.]

In my article on this subject, published in your last issue, there are, unfortunately, certain errors which it is important that those readers who are interested in the subject should be made aware of. The two most serious errors occur in the figures relating to the Phaeton 16 C.P. lamps, and in the final watts per candle of the Siemens & Halske 16 C.P. lamps. The figures in the table of averages of these types of lamps are :—

	Commencement.			350 hours.			600 hours.		
	A.	C.P.	Watts per C.P.	A.	C.P.	Watts per C.P.	A.	C.P.	Watts per C.P.
Phaeton	·66	18·29	3·65	·70	16·5	4·4	*·68	14	4 8
Siemens & Halske ...	·57	15·10	3 82	·57	15·50	3·75	·55	12 10	4 74
Instead of									
Phaeton	·66	18·29	3·65	·70	14·37	3·90	·68	13·60	4·00
Siemens & Halske ...	·57	15·10	3·82	·57	15·50	3·75	·55	12·10	4 05

* Mean of three lamps.

A less important error in the same table occurs in the average current consumed by the Gabriel & Angenault lamps, which, at the start, at 350 hours, and at 600 hours, should read ·49a respectively, instead of ·47a, ·48a, ·49a. The steadiness of the current throughout the run of these lamps is somewhat striking, for it is not only that the "means" remain unaltered, but the individual currents are also unchanged, and this, in face of the fact that the average incandescence is unusually high, and of the lamps being not very equal in efficiency at the start. This feature may be a mere coincidence, for the 8 C.P. lamps of the same maker change variously in resistance in the respective lamps. The Stearn 16 C.P. lamps are also very equal in resistance throughout the run, and the 8 C.P. lamps of the same maker, although starting with different currents, end off with a current of ·33a in every case.

In the table of averages of the 8 C.P. lamps, the note "mean of three lamps" applies to the Fleischhaker lamps, not to those of the Daylight.

With reference to the querying remarks made by Mr. Frederick Walker in your last issue as to the superiority of the Gabriel & Angenault lamps over the Robertson, this gentleman should bear in mind that the two makes of lamps, both 16 and 8 C.P., started at very different incandescence. Hence, strictly speaking, no satisfactory comparison *can* be made. But scientific accuracy aside, in point of uniformity of candle-power the palm must certainly be conceded to the Robertson, whilst in the matter of minimum watts per candle, in the 8 C.P. lamps in particular, the advantage lies unquestionably with Gabriel and Angenault.

Life tests of the nature that Mr. Paisley has magnanimously brought to public notice are of very considerable interest. Let us hope that this one is only the precursor to other and more extended trials in which steps are taken to have the initial efficiency of the respective lamps more uniform. There are, it may be mentioned, several European lamp manufacturers not respresented in the present trial. The matter might well be taken up, it seems to us, by certain flourishing firms who have extensive workshops lighted by incandescent lamps, and supplied, by preference, with current from a central station. Many a young electrician would be only too glad to get the job of making the periodic photometric readings, and other observations connected with the trial, at times when light is not required.

PROCEEDINGS OF SOCIETIES.

The Société Internationale des Electriciens.

The Distribution of Electrical Energy at Paris.

The meeting of November 6th, 1895, of the *Société Internationale des Electriciens* was occupied entirely by the very complete studies of the distribution of electrical energy at Paris, made by Messrs. F. Meyer and J. Laffargue.

M. Laffargue dealt with the purely technical side of the subject, and M. Meyer with the commercial side.

M. Laffargue first called attention to the fact that the distributions of electrical energy were established in Paris in 1887, after the burning of the Opéra Comique. The Municipal Council granted concessions in 1889. Then were installed the Continental Edison Company, which, with its stations at Dronot, the Avenue Trudaine and the Palais Royal, has a total power of 3,080 kilowatts; the Société d'éclairage et de force par l'électricité, whose various stations of St. Ouen, Barbès, the North, Bondy, Filles-Dieu, La Villette and the Abattoirs have a total power of 2,688 kilowatts; the Clichy Sector Company, effecting the distribution by the 5-wire method, with a power of 2,470 kilowatts; the Paris Compressed Air and Electricity Company, with the stations of Saint-Targeau and the Boulevard Richard Lenoir, having a power of 2,200 kilowatts, will shortly add the station of the Quai Jemappes, which will have for the present a power of 2,400 kilowatts, and will effect the distribution by the 5-wire method; the Sector of the Champs Elysées Company, having at present a power of 1,200 kilowatts with alternating currents at 3,000 volts, and being about to add another alternator of 400 kilowatts; the Left Bank Sector Company, which is now establishing outside Paris, at Issy, on the Quai de la Seine, a station of 4,000 kilowatts, comprising 10 Ganz alternators of 400 kilowatts at 3,000 volts, with alternating currents. The municipal system still has a power of 570 kilowatts, 240 from continuous currents and 330 from alternating currents. At the end of the year 1895, therefore, the total power of the central stations of Paris will amount to 19,100 kilowatts for feeding 454,560 incandescence lamps of 10 candles, and 154 engines of a power of 331 kilowatts. M. Laffargue showed by diagrams various curves of consumption of different sectors for one day in the month of October, 1895. Then he constructed a curve summing up all these individual consumptions. The maximum amounts to 6,778 kilowatts towards 6 p.m. The quantity of electrical energy furnished by the stations to the consumers has rapidly increased from 2,284,485 kilowatt-hours in 1890 to 7,883,434 kilowatt-hours in 1894. In conclusion, M. J. Laffargue discussed the private installations of electric lighting in existence in Paris, and he found that the total power utilised in these installations was 25,760 H.P., 23,000 for steam engines, 2,260 for gas engines, and 500 for compressed air engines.

M. F. Meyer afterwards spoke of the commercial working of the sectors.

THE RATING AND BEHAVIOUR OF FUSE WIRES.*

By W. M. STINE, H. E. GAYTES, and C. E. FREEMAN.

(*Concluded from page* 606.)

It was thought best to study the influence of "fatigue" on a wire. A special board was prepared with two rows of insulated pins placed 10 inches apart. A length of fuse wire was threaded back and forth over these, the wire being supported out of contact with the board. A current, just short of the fusing strength, was passed for 7 hours. The results are plotted in fig. 8. It will be noticed that the A fuses experienced a position fatigue, the B wire a

Curves of fatigue. Constant length 8".

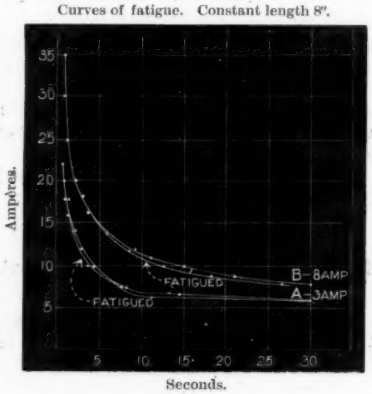


Fig. 8.

negative one. This is of importance in practice, and shows the superiority of the B wire, whose fusing point was lowered while the other was raised, due to a diminution of cross-section and absence of oxide film.

Curves for position. Constant length 8". 15-ampère wire. Brand A.

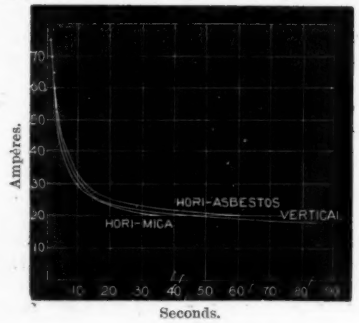


Fig. 9.

A great deal has been said about the influence of grease films on lead fuses. This point was also investigated. The grease was removed from the wires by immersion in KOH and Na OH with subsequent washing. In other cases the wire was cleaned

Curves of fusing points. Constant time 30 seconds. Brand B.

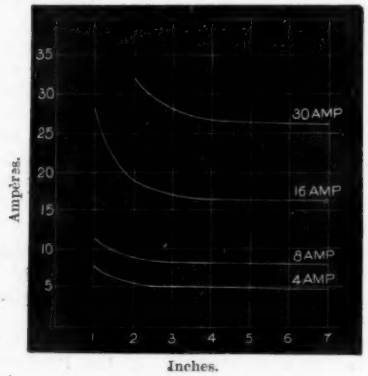


Fig. 10.

by the use of fine sand-paper. The oxide film was also removed by immersion in nitric acid. Measurements showed that this treatment did not sensibly reduce the cross-section. When the oxide film was removed by either mechanical or chemical means, it was noticed that a thicker coating formed at once, raising the fusing point. In short, these tests showed that nothing was gained by cleaning the wires, but that the thin film of grease deposited during the drawing of the wire was rather an advantage. The wires were also coated with shellac, but without encouraging results. Some coating, not affected by heat, and which would reduce the radiation, would doubtless increase the stability and sensibility of fuse wires.

For the following tests an adjustable fuse block was constructed on which the fuse was held about one inch above the base and supported each inch by either thin asbestos or mica supports. In order to ascertain the influence of these supports, tests plotted in fig. 9 were made. The influence of hydrostatic pressure is shown by the horizontal curve with the asbestos supports being higher than the vertical curve. The curve with mica supports is lower for the reason that the mica cut the softened wire.

A singular phenomenon was noticed with the A fuses blown horizontally in the 8-inch block. The arc would usually occur at about the same place near the centre of the fuse, and when the time was within six seconds, the entire fuse was shattered into

Curves of fusing points. Constant time 30 seconds. Brand B.

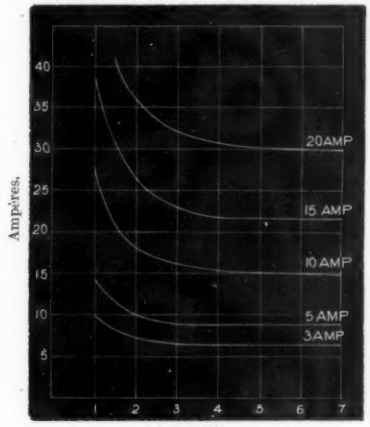


Fig. 11.

approximately equal lengths, varying from $\frac{3}{8}$ths inch to $\frac{3}{4}$ inch, depending upon the current employed. The length of these pieces varied inversely with the current strength. The uniformity of these results were noticeable throughout all our tests. The entire fuse, to within a short distance of the terminal, seemed to explode into fragments simultaneously with the formation of the arc. This rhythmic action has been pointed out by the author for copper wire fused by lightning.* The ends of such pieces invariably showed a crystalline structure, indicating that the entire fuse was melted, and prevented from flowing by the oxide film.

So much seems to depend on the cooling effect of the terminals that it was determined to work this point out with great care. The terminals of the adjustable block were made of brass, and purposely made unusually massive. Care was also exercised to keep the

Curves of fusing points. Constant times. 10-ampère wire. Brand A.

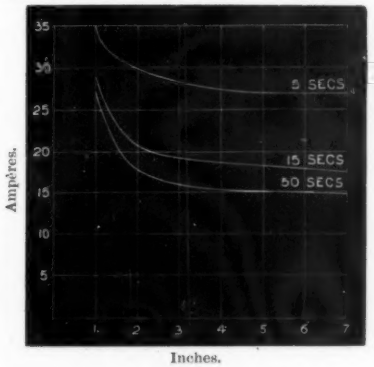


Fig. 12.

terminal contacts bright and clean. Constant fusing times were adopted, with varying lengths. This method of experiment is extremely tedious, since it is not only difficult to ascertain the exact current for a length in a given time, but any slight draught or variation in the current will produce a sensible modification in this time. Up to this point the current has been obtained from a 50 kw. 110-volt D.C. dynamo, furnishing a sufficiently constant E.M.F. For the following tests a storage battery of 60 180-ampère-hour cells was employed. The result for a constant time of 30 seconds is shown in figs. 10 and 11; and for constant times of 30, 15, and 5 seconds in figs. 12 and 13. The relation between size of wire and length of fuse

* Presented at the meeting of the American Institute of Electrical Engineers, New York and Chicago, October 23rd, 1895. Subject to revision.

* *Electrical Engineer*, July 13th, 1895, p. 38.

for maximum sensibility is shown by the curves of figs. 10 and 11. The curves of fig. 13 exhibit well the sluggish action of the fuse wire. For 5 seconds 2 inches is the critical length, while for a time of 30 seconds it is nearly 5 inches. Data for times longer than 30 seconds are not materially different from those at this period. For a given fuse, then, blown in a given time there is a critical length. We are now in possession of full data for the complete discussion of this most important question.

If a fuse is to be employed for maximum sensibility at normal rating, the curves of fig. 11 will enable the length to be determined by the location of the critical point in the curve, which is the point at which the cooling effect of the terminals becomes marked. For three and five ampère fuses, lengths of 2½ inches should be employed; the 10 and 15-ampère fuses indicate a length of 3½ inches, the 20-ampère of 4 inches. Judged of by common practice these lengths seem excessive, but the data clearly indicate where practice might be corrected.

Comparing the curves in fig. 2 with these, it is readily seen that the effect of the terminals is equivalent to shortening the time as in fig. 13, and so increasing the carrying capacity. But these short lengths in no case fuse normally. It is only adding the complexity

Curves of fusing points. Constant times. 15-ampère wire. Brand B.

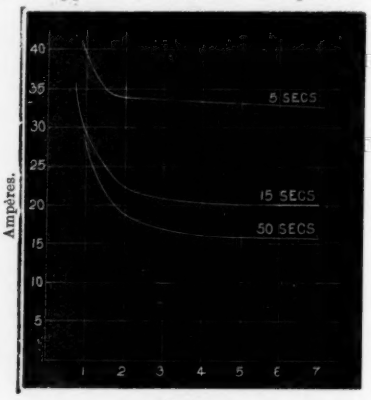


Fig. 13.

of the fuse to the uncertainty of the contact. Should the fuse itself become oxidised, the carrying capacity will be largely augmented. We believe sufficient data has been presented to show that it is poor practice to employ short lengths to economise in porcelain.

We may now summarise some of the practical conclusions deduced:

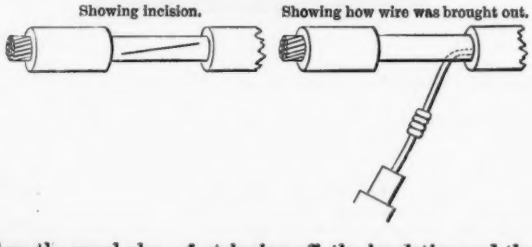
1. Covered fuses are more sensitive than open ones.
2. Fuse wire should be rated for its carrying capacity for the ordinary lengths employed.
2. (*a*) When fusing a circuit, the distance between the terminals should be considered.
3. On important circuits, fuses should be frequently renewed.
4. The inertia of a fuse for high currents must be considered when protecting special devices.
5. Fuses should be operated under normal conditions to ensure certainty of results.
6. Fuses up to 5 ampères should be at least 1½ inches long, ½-inch to be added for each increment of 5 ampères capacity.
7. Round fuse wire should not be employed in excess of 30 ampères capacity. For higher currents flat ribbons exceeding 4 inches in length should be employed.

Armour Institute of Technology,
Chicago, *October 1st*, 1895.

CORRESPONDENCE.

Jointing of Electric Light Wires.

Having had occasion to take off at intervals along a 7/18 cable some single 18 wires for lighting single 16 C.P. lamps, I adopted the following plan, which seems to me far better



than the usual plan of stripping off the insulation and then twisting the single wire round the cable and soldering it, whereby the insulation for several inches on each side of the joint is ruined by the heat necessary for soldering, besides the difficulty of insulating it again. I carefully stripped off the outside serving of the cable, thereby exposing the rubber for about 3 inches. I then inserted the point of a knife through the rubber and in between two of the wires of the strand, and then drawing the knife along and following the twist in the strand, I made an incision about 2 inches long through the rubber. Then at one end of the slit I put the point of the knife through and cut one of the wires, which I now pulled out through the slit and twisted and soldered my single wire to it.

I think the rough sketch makes it plain how I did this.

I then cleaned the rubber, put a little rubber solution in the slit, and bound it over and made the joint in the usual way with rubber tape.

You will see the heat required to solder the single wire is very little, and there is certainly less damage done to the cable in all respects than by the usual method.

This method may not be new, though I have never seen it, and I think it will commend itself to any engineer as being far better than the old plan.

Ernest Perrett.

Lewisham, *November 14th*, 1895.

"The Engineer's" Review of Professor Jamieson's Applied Mechanics.

May the critic be himself criticised? In your contemporary, *The Engineer's* issue of October 25th, is a notice of "A Text-book of Applied Mechanics," by Andrew Jamieson, which can only mislead the hundreds of young engineers who naturally attach great weight to the dictum of such an important journal.

Here is a work bearing evidence of great pains and research, and which, at any rate, attempts to put in the clearest light many problems of admitted difficulty. Your contemporary regards such an aim with a superciliousness almost amounting to contempt, pooh-poohs mathematics, and sets up as his ideal that dreadful person, "the average engineer," with a piece of chalk proving problems with a few strokes on a brick wall.

This is the language of 20 years ago. The idea that the educated man cannot be also eminently practical has been long since exploded. We are all of us ignorant enough, heaven knows; but we can by a frank recognition of that ignorance, and by a lifetime of work and study do something to amend the misfortune. But compound ignorance, the ignorance of being ignorant, is an incurable disease, and is, worse luck, contagious. Is it not deplorable that one in a position to influence the rising generation should write, "The algebraic x is only x, and nothing more until we attach a definite value to it."

Who are the men in our own day who have really done good work and left a mark on the world? Practical mathematicians, Lord Kelvin, Thornycroft, Willans, Siemens, to take four different walks in engineering. What were and are they? Chalk and brick wall men? I trow not. Look at the other side of the question. How many railway bridges have failed in America for want of that theoretical knowledge which the *Engineer* decries? I have never heard it said that the workmanship was defective, the constructors were tip-top carpenters and smiths, but they lacked the one thing needful. Look at Edison's field magnets, set right by the theoretical Hopkinson. Which is better, to say with Kepler, "After a life's observation I *think* I see a law, viz.: that equal areas are described in equal times by planets," or to show with Newton in a few lines that that truth necessarily follows the law of inverse squares?

In electrical engineering what dynamo or motor could be designed without *quantitative* calculations? and how have these been arrived at but by the theoretical engineer armed with his skeleton key—mathematics.

The *Engineer's* criticism of Prof. Jamieson's treatment of the screw is legitimate enough. If the Professor means: "If the pitch angle be greater than 45 degrees," *then and then only*, "it will be possible to reverse the action of the screw," the professor is wrong and should be brought to book. But I read the sentence differently. Earlier in the same lecture the case of the inclined plane *without friction* has been considered, and the reader surely can see that under that condition *all* screws are reversible. I read it thus: If the pitch angle be greater than 45 degrees it will be

"*always* possible to reverse the action of the screw," *irrespective of the coefficient of friction;* since, if the friction is small enough to allow the one motion, *a fortiori*, will it allow the other.

As to the relative importance of toothed wheels, that, of course, is a matter of opinion. But the subject is not to be so easily disposed of as the *Engineer* would have us believe. It is easy to say "make them beyond suspicion with regard to strength," the question is, *how?* If the *Engineer* will show how to make the pinions of a three-roller cane mill in cast iron, and above suspicion with regard to strength, he will earn the gratitude of every one connected with the cane sugar machinery trade, except the Sheffield steel founders.

As to the definitions employed by the Professor, the critic ought not to condemn them wholesale without pointing out one single instance of an *antiquated*, or *erroneous*, or *incomplete* definition.

For my part I cannot see any fault in them, still, there may be better; but it strikes me that any important change would affect the whole subsequent argument. Such criticism as this is unworthy of the name; it is the criticism by the teetotaller of a certain brand of wine. It is to be hoped that Professor Jamieson will not be deterred by it from carrying out his second volume on the same lines; and that no young engineer will be seduced by this specious reasoning from the attempt to master what I may call the *grammar* of mechanism, the underlying principles on which all construction rests.

C. A. Matthey.

November 17th, 1895.

Decay and Preservation of Telegraph Poles.

I notice in your issue of the 15th a letter from Mr. F. T. J. Haynes, in which he is, in relation to a paper read by me before the Institution of Electrical Engineers in 1874, good enough to bring under the notice of your readers the fact that there are still standing in his division some sound Boucherised telegraph poles which were planted in 1864, whilst others bearing the same date are being renewed.

This information is exceedingly interesting. The Boucherising process, as applied to telegraph poles, has now completely passed out of practice. It is, I believe, no longer used; but the information which Mr. Haynes has afforded, perfectly confirms the view which, so far as I am aware, always attached to Boucherised poles, viz., that it was unreliable. Whether, however, that is the result of want of care in application, or of the nature and growth of the wood, it is difficult to say. I should be inclined to attribute it to a degree of unfitness in the timber, which requires to be placed under the process at a time when the natural sap of the tree is rising, and which means that the tree has to be cut down in the spring and placed under the process at once. If the sap passages have become partially closed, the sulphate of copper takes much more time to pass through the tree, and possibly those parts in which decay eventually arise are portions which have not been properly impregnated.

Boucherised poles have one advantage over creosoted poles. They can be painted with better results than can creosoted poles, but there can be no question that creosoted poles are by far the most reliable, and the most economical.

As one of your readers, I am greatly obliged to Mr. Haynes for his information.

W. Langdon.

Derby, *November*, 1895.

The Institution of Electrical Engineers.

The storm which is now raging round the presidential chair was forecast long since by those who live surrounded by the elements. It has been brewing for years, and it cannot be said that frequent warnings have not been given in your own and other technical journals. It is the inevitable outcome of the method in vogue for election to the membership of the Institution, and the odd medly that results therefrom.

I have only this moment received a communication from a bagman, whose knowledge of electrical engineering is limited to the few phrases he repeats when pushing his wares. This gentleman writes M.I.E.E. after his name.

The qualifications for membership being in practice what they are—the technical knowledge of the ordinary member being what it is—there is difficulty in wholly agreeing with the able article published in your last week's issue, having regard to the present composition of the Institution.

Sir David Salomons has both scientific and technical knowledge that place him well in advance of the average member; why, then, should he not be president? That a better man might be elected can obviously be said of every possible selection save one.

It has long been felt that there should be two classes of members in addition to the Associates; be this how it may, a far wider distinction should be drawn between members and Associates than has hitherto been the case.

At the present time, anyone can become an Associate; let him but remain an Associate for awhile, and he can without difficulty become a Member, provided he is willing to pay an increased subscription, although his claims to the name of electrical engineer be *nil*. This is altogether wrong. Let such people join the household by all means, but only as a species of paying guest, and let them enjoy every privilege save that of management or assumption of the family name.

It has been objected that such a strict division would give dire offence to many. Why so? No civilian, however great his self-esteem, chafes because he is excluded from the membership of a military club. Why, then, should an honourable man who is not qualified, feel aggrieved because his name cannot be included in a list of men who are?

If any man desires to have a spurious diploma with which to deceive people at large, let him seek it elsewhere than at the Institution of Electrical Engineers. It goes without saying that anyone who has gained a privilege, however incompetent he may be, will keep it; but under a new *régime* the ranks of the Institution might be purged of quacks, and the status raised with remarkable speed.

An opportunity is given to Sir David Salomons such as has fallen to the lot of no other Vice-President. He may refuse to pose as the type of what the professional electrical engineer should aim to be, as opposed to the brilliant amateur.

It is not enough, however, that Sir David should play the part of Curtius, or the chasm will but reopen wider in the near future. Why, indeed, should Sir David Salomons give up the Presidency so long as a less qualified and less gifted man may be promoted to the vacancy?

Let a condition of his withdrawal, if he does withdraw, be the ending of the present pernicious system of election.

If Sir David Salomons is self-sacrificing enough and strong enough to achieve this, he will confer a greater and more lasting good on the Institution than he could by any possibility have done from the Presidential Chair.

Hugh Frat Harrison.

There can be little question that the majority of members and associates of the Institution of Electrical Engineers have cordially endorsed the opinions set forth in last week's electrical press; but it has since become apparent that the Council intend to persist in the nomination of Sir David Salomons to a position which he and they must fully know should only be occupied by a man of great distinction in electrical science and engineering. All of us appreciate how much the Institution of Electrical Engineers owes to the Institution of Civil Engineers, and the intercourse between the societies must be mutually useful. It is to be hoped that in the coming election the Electrical Engineers will take a leaf from the book of the parent society, and follow their policy in such a matter as this, for it would be humiliation indeed if, in the same year as the Civil Engineers have appointed the most distinguished engineer in England (if not outside of it) to be their chief, the Council of the Electrical Engineers succeed in electing to a similar position a most worthy and benevolent *dilettante*. It will be pitiful, too, if the Council succeed in putting pride in its own procedure above the interests of the Institution. It has already become quite apparent that, however ingenious and influential may be the support of the Council's nominee, the justification of its choice is feeble enough. The Council must further know that its action will be opposed by a large part of the youth and energy of

the profession, who have a strong ally in time, and who most firmly believe in the principle for which they are contending. It might conceivably be the great privilege of some of those young engineers to write the biographies of the distinguished gentlemen who now control the destinies of the Institution, and it would be sad to have chronicled the notable disservice the promoters of Sir David's candidature are rendering to their own constituents. This movement has been carried on, so far, with a great desire to avoid personalities, and to leave unimpaired the dignity of the Institution. This spirit will be continued through the contest which has been challenged, if it is clearly remembered that the opponents of Sir David have no other motive than the preservation of the high scientific renown which previous presidents have won for an Institution which has already become a factor of no inconsiderable importance in the industrial development of the empire.

Alfred E. Mavor.

A Neighbourly Act.

Having my own electrical plant, and possessing more power than required by myself, am I at liberty, without infringing the law, to supply current to my neighbour.

J. W. Kennedy.

[There is nothing to prevent our correspondent supplying his neighbour with electric energy, providing he does not cross the street.—Eds. Elec. Rev.]

Strictures.

I understand that there exists a disbelief amongst electricians as to the truth of the claim that strictures of the urethra and other anatomical passages can be cured by electrolysis. Ever since the Harness exposure, genuine medical electrical science has suffered severely, because not only the general public and the medical profession, but also (and chiefly) because electricians have come to regard medical electricians as all tarred with the same brush, that of charlatanism. I find myself continually having to stand up in defence of real medical electricity, and though I am fully aware that I shall expose myself to be "jumped upon" by the gentleman who does the criticisms in your journal, on account of such slips in verbal expressions as I shall probably make, I venture to give a few details of the manner in which stricture of the urethra is undoubtedly cured by electrolysis.

A battery is used which is capable of giving a margin of current beyond that actually needed; but, as the resistance of the parts at one pole is far less than in most medical applications (the moist and warm mucous urethra), and the resistance at the other pole can be greatly reduced by using a very large area of electrode well moistened at some distant part (such as under the loins as the patient rests on a couch). A far smaller battery is needed than for applications where both electrodes are on the skin, and one at least small in order to direct the current to some definite spot. Five milliampères must be passing during electrolysis and the current must be imperceptible when the catheter shaped electrode attached to the negative pole is passed down to the stricture; the current also must be increased by extremely fine gradations, the addition of a cell at a time being far too sudden. Any rapid change of strength causes spasm, which seriously complicates the judgment; it is necessary to use a rheostat with a delicately graduated sliding resistance. Taking the body resistance to be approximately 200 ohms and the galvanometer having 1,000 ohms (milliampèremeter), we use a battery of 10 volts E.M.F. (here I shall be "jumped upon I expect!), this will give about 8 milliampères when the body resistance and galvanometer are in circuit. Our sliding rheostat must have in all enough resistance to allow only of an imperceptible current when the negative electrode is first brought into contact with the sensitive urethra, or when the cells are first switched on—8,000 ohms gives a good margin for the rheostat.

The positive pole having been attached to a large covered and well moistened metal plate, placed under the loins as the patient rests on a couch, the cathether shaped electrode is chosen, which will only pass the stricture with a little force, and this force is never exerted; the negative pole is then connected with this electrode (the tip only of which is bare) and the rheostat adjusted gradually, taking out resistance by very slow degrees until the milliampèremeter indicates 5 milliampères as passing (most patients feel a slight tingling at this point, beyond which no inconvenience need be caused). Pressing the electrode end very gently and steadily against the resisting stricture, if it be not a very old and fibrous one, the electrode will, after a few minutes, be felt to slowly glide onwards, and, perhaps, even at the first sitting it will slip through the constriction; on withdrawing it far less obstruction to its passage will be felt. At subsequent sittings larger electrodes are used, and so on until the cure is complete.

There comes away on the electrode a quantity of "débris," literally "broken down" cellular and fibrous material—representing the obstructing tissue—and it is important to note that this discharge (which also continues to come away for a day or so after the application) is not such as would be produced by either actual or chemical cautery. It has been argued that one or other of these is the rationale of the cures. Actual cautery is, of course, an absurd supposition, because the small current and the small resistance of the electrode precludes it (or, should I say, the small E.M.F. ?); whilst the alkaline reaction of the products of electrolysis at the negative pole is, of course, undeniable; yet it is not of that concentrated caustic nature that would produce tissue destruction. Further, there is less liability to subsequent contraction in stricture thus electrolysed than after other methods (such as the cutting, stretching, or splitting of orthodox surgery).

This is giving more detail than perhaps will be approved as fit for publication in a journal not devoted to surgery; but I am anxious to prove that there is in this instance some approach to scientific claim in medical electricity, and I can confidently say that many other applications of the current in medical work will as little bear the imputation of quackery.

Gerard Smith, M.R.C.S.

Incandescent Lamp Efficiencies.

Your issue of November 1st contains an article upon "Incandescent Lamp Efficiencies," which is founded upon a table contained in *Industries and Iron* of October 4th.

Our objections to this table are :—That the table does not state *where* the tests were made, or *by whom* they were made.

We thould have thought it would have been obvious to everyone that a table of this kind was absolutely without authority, and was, in fact, valueless for practical purposes. But it has been largely commented upon, and it is, therefore, calculated to do serious injury to the makers of lamps whose manufactures are reported upon in, what we submit is, an exceedingly unfair way. The results which you have arrived at are entirely opposed to our experience. We are ready and willing to have our lamps tested in opposition to any others, but the test must be made by persons whose names are known and whose position is a guarantee at once for absolute independence and high scientific attainment.

We are somewhat surprised to find that a paper of your standing has used unauthenticated tables of this kind upon which to found an article which is calculated to do great prejudice to ourselves and other firms, and we must call your attention to the unfairness of such a proceeding.

We must ask you to give our letter proper publicity.

The Sunbeam Lamp Co., Ltd.,
John W. Edmundson, *Managing Director.*

[We shall reserve our reply to this till next week.—Eds. Elec. Rev.]

On glancing through your issue of the 1st, we find an extract of recent tests of incandescent lamps which gives the curves of four English made lamps. We anticipate you intend publishing the tests of the other makes, thus giving a fair opportunity to your readers to find out for themselves which lamp is really the "best in the market," and not to trust to interested statements in the advertisement columns of your valued paper.

It is rather funny to look through the latter and to see on one page a firm claiming, on the strength of your published tests, that their make of lamp is really the "best in the market," while a few pages further on we find the advertise-

ment of another firm basing the result on the total of the tests, and, perhaps, more justly claiming that *their* lamp is "the best."

We have very likely the same "unbiassed" and independent test before us which your curves are based on, and therefore take the liberty of enclosing herewith the curves referring to 15 differently made lamps, which we should venture to ask you to be kind enough to publish, should you not already have prepared similar ones as a continuation of the article already appeared.

We do not fear of being accused to speak "*pro domo*," although we hope to be benefited by the publication, which will tend to prove that *not* all continental made lamps are "far outstripped" by the English manufacturer, as you put it in your first article.

The International Electric Company,
H. Oppenheimer, *Manager.*

[This communication came to hand before the publication of the lamp table last week: as our correspondents have based the curves on this table it is unnecessary to reproduce them.—Eds. Elec. Rev.]

Higher Voltage Lighting.

With reference to the discussion on the subject of raising the E.M.F. of continuous current supply stations (Hull, St. Pancras, &c.), I beg to suggest the following method, which I am advocating in similar cases:—Allow a substantial discount to all consumers taking a supply at the higher voltage (raising the price to others if necessary). This may be applied to all alike or to old consumers only, new ones being supplied only at the higher voltage. In the case of a large consumer having more than one meter, the change may be made gradually, leaving one circuit on the low tension till the old lamps are used up as far as possible. A small allowance may be made for old lamps to be used up in the station, where there will be no advantage in using the higher pressure (except for experiment) until the change is complete, and even then any pressure may be taken from the batteries. When by this method the bulk of the consumers have been induced to make the change, it may be enforced on the remainder with comparatively little friction. It is of some importance to arrive at the easiest method of making a change which will put continuous current stations more on a level with alternating as regards capital outlay, and enable them to supply power economically for tramways from the same plant as for lighting purposes.

Arthur J. Hills.

November 19th, 1895.

THE LILLE EXPERIMENTS ON ROPE GEARING.

Prof. Capper's recent paper before the Institute of Mechanical Engineers will be of interest, in that some of the results are at variance with generally accepted figures. Thus, for example, it has been customary to regard a belt as absorbing something like 5 per cent. more power than good gearing, and ropes as absorbing even 10 per cent. more. Referring to the experiments of Lelautre in 1878, he states that good spur gearing had an efficiency of 93 per cent., whereas a belt showed 95 to 96 per cent., and the Lille trials just made show that ropes are equivalent to belts. These Lille tests were made at the instigation of the Société Industrielle du Nord de la France, and an engine of 200 H.P. was furnished free by M. Dujardin, an engineer of Lille. This had two fly rims, each 4½ metres diameter, one for ropes and one for belt, and it drove a dynamo similarly equipped and placed on a sliding bed so that the belt tensions could be regulated by screws.

The ropes were made by Saint Freres, of Paris, of manila and of hemp. Why was there not a test with cotton ropes?

The belts were respectively of cotton by Lechat, of Ghent and Lille, leather by Lemaire, of Tourcoing, and homogeneous leather by Domange, of Paris, and experiments with ropes and belts were alternated at the rate of several per day. The dynamo was furnished by the Alsatian Company, and 1,800 lamps by Gabriel and Angenault, of Paris, and 300 by Henneton, of Lille, and so on, all the apparatus and expense being furnished by different manufacturers. It was endeavoured to provide a constant resistance and to debit any difference to the means employed to transmit the power, and the resistance was in the form of a quantity of incandescent lamps, and indicator diagrams were taken at normal speed.

Without entering into details the reliable tests showed as follows:—

Ropes	Gross power 158·54 I.H.P.	Slip 0·33 per cent.
Cotton belt	" " 159·67 "	" 0·78 "
Leather belt (Lemaire)	" " 158·84 "	" 0·96 "
Leather belt (Domange)	" " 160·23 "	" 0·78 "

Stated in percentage values and allowing for variation in the mean load, the above four results become—

100·00 I.H.P.	Slip 0·100 per cent.
100·87 "	" 0·237 "
100·37 "	" 0·292 "
101·07 "	" 0·237 "

and the speed per second and tension per square inch of the four sets was:—

66·9 per sec.	under 156·5 lbs. tension.
67·2 " "	" 177·5 " "
67·1 " "	" 133·5 " "
67·3 " "	" 156·1 " "

The conclusion of Prof. Capper is, that ropes are about equally efficient with belts, a statement with which we think few engineers of experience will be disposed to agree in the absence of supporting testimony.

In the discussion which ensued there was not much said. One speaker seemed to advocate such high speeds as 6,000 and 7,000 feet per minute, but the speaker made no allusion to the fact that 4,800 is about the limiting economic speed for accepted unit stresses and should not be exceeded unless for reasons of a special nature, and Mr. Saxon drew attention to this as embodying the practice in Lancashire where 5,000 is the usual limit and ropes were now very usually only 1½ inches diameter, the Lille experiments being with 1¾ ropes.

He also pointed out that the experiments were not altogether practical in view of the fact that tension adjusters were used, and this cannot be done in a factory. Then cotton was the material for ropes in Lancashire and he wondered why cotton was not tested.

Other speakers put in their say but said nothing, and Professor Kennedy waxed sarcastic when Mr. Longridge stated that it was Lancashire practice to run engines at full power, the professor evidently not believing it possible to estimate beforehand the power that a cotton mill will absorb nearer than about 15 per cent., and speaking as though Mr. Longridge had claimed to be a prophet, whereas had Professor Kennedy given a moment's consideration to the actual facts he might have saved his sarcasm and accepted Mr. Longridge's knowledge as accurate. There is every day less of a common ground on which to compare ropes, belts, and gears. The conditions are now so different and rope geared engines so large; but the general impression is that toothed gearing when decently designed will not absorb so much in friction as either belts or ropes, and though both the latter have been improved of late years, so, also, have toothed wheels, and no man in his senses would now design large wheel teeth with a length more than half their pitch. Indeed, for pitches as small as 1¼ inch and 1½ inch teeth of half pitch in length are quite sufficient and will work with less noise, friction, and danger, than longer teeth. Not only do we think that gears owe their desuetude more to bad design and construction than to any inherent fault of principle, but we also think that the belt was never given a fair showing in large factory driving before ropes came in and dispossessed it. A main driving belt is, when properly made, a very different article from one just simply put together. Every hide in a belt ought to be properly stretched in the hide, and the belt properly cemented and sewn, and similarly ropes ought to be carefully made of a uniform number of threads. The very nature of a cotton rope renders the attainment of absolute uniformity in size and weight very much more easy than in a hempen rope, the yarns of which a cotton rope is made being easily secured very uniform, while at the same time fine and capable of being built into uniform strands.

We are glad to see that the paper contains an apology and correction for having measured the circumferences of belt pulleys upon the pulley rim instead of at the middle thickness of the belt.

BUSINESS NOTICES, &c.

Asbestos Fuses.—The Carboid Oil-less Bearing Company, Limited, write, in reply to a correspondent's query published last week, "We have for some years manufactured foil fuses with both asbestos and fibre supports. We certainly prefer a mica support and supply the Hedges mica foil fuse in its original form, which we have found to stand the test of years of work in a remarkable manner."

Ashantee Expedition.—The hospital ship to be engaged by the Government for the Ashantee Expedition will be fitted with electric light. The questions of light and ventilation are said to have received great attention.

Electric Heating and Cooking.—The many and varied purposes to which electricity is being put in heating and cooking, may be gathered from the catalogue recently issued by Messrs. Crompton & Co., Limited. There are some opening comments as to how electricity heats, the general principle of the Crompton-Dowsing system is explained, and some probable causes of failure are stated for the guidance of the user. Some neat illustrations are given, also prices of electric kettles, urns, saucepans, grills, ovens, hot-plates, radiators, curling-iron heaters, and other articles of domestic use. One page is devoted to illustrations showing a few of the many other domestic applications of electromotive power, *i.e.*, electric fan, hair brushing, knife cleaner, mangle, &c., the current being derived from small Crompton motors. Some "useful hints" for general information in connection with the use of the apparatus are given at the end of the catalogue, which altogether is a very interesting one.

Bankruptcy Proceedings.—A dividend will be paid on December 26th in the bankruptcy of Browning & Gardner, electrical engineers, Edinburgh, at the office of J. H. Buchanan, C.A., 8, York Place, Edinburgh.

On October 2nd, 1895, a petition was entered at the Wandsworth Court, and on November 15th, 1895, an adjudication order was made in the case of Walter Raynes Smith, electrical engineer, of St. Andries, Hitherfield Road, Streatham, Surrey.

Dissolution of Partnership.—Messrs. E. Hodgson, A. Blackburn, and J. Walker, hitherto trading as electrical engineers, at Toft's Mill, Cleckheaton, as Blackburn, Walker & Co., have dissolved partnership by mutual consent as from November 4th. The business will hereafter be carried on by Arthur Blackburn and Jas. Walker under the same name as formerly.

Liquidation Notices.—The *London Gazette* contains notification that a meeting of the Taunton Electric Lighting Company, Limited, will be held at 3, Hammet Street, Taunton, on December 20th, at 3·30 p.m., for the purpose of having an account of the winding up laid before the shareholders.

Notification has been published in the *London Gazette* that at a meeting of the Collier-Marr Telephone and Electrical Manufacturing Company, held at 77, King Street, Manchester, on 13th inst., a resolution was passed winding up the Company voluntarily as it could not, by reason of its liabilities, continue its business. Mr. Wm. Frost, of 77, King Street, Manchester, was appointed liquidator.

Creditors of the Printing Telegraph and Construction Company of the Agence Havas, Limited, remaining unpaid are required, on or before December 31st, 1895, to send their names and addresses and the particulars of their debts or claims, and the names and addresses of their solicitors, if any, to W. H. King, of 13 & 14, Basinghall Street, E.C., the liquidator of the company.

Hunter & Jack v. Kirsopp.—We referred to this case in our July 5th issue. The Sheriff at the Linlithgow Court has now issued an interlocutor in which he finds that pursuers having completed the work they are entitled to payment of the sum sued for. The lamps, he says, which were at first fitted up were changed for two lamps of a different pattern; that one was removed and placed in a higher position by the defender without the sanction of the pursuers; that defender ought either to have left the arc lamp in the position in which it was at first placed, or called in the pursuers to remove it.

The Imperial Telephone Company, Limited v. The Electric Novelty Syndicate, Limited.—This action came on for hearing at the City of London Court before Commissioner Kerr on Tuesday last. Mr. James Welfare appeared for the plaintiff company, of 35, Queen Victoria Street, who sought to recover the sum of £5 13s. for goods sold and delivered to the defendants, said that the defendants were in negotiation with the plaintiffs to purchase the patent of the Imperial Telephone Company. At the suggestion of Mr. Watson, who was in fact the plaintiff company, the telephone was put up in the defendants' office, preparatory to working it. The defendants declined to purchase the telephone, and had asked Watson to take it away. Instead of doing that he had sued the defendants. Evidence was given that the defendants had purchased the instrument, but the case was adjourned for the attendance of Mr. Watson.

The Pneumatic Telephone Ring.—This is an article being supplied by the sole agents in this country, Messrs. Ellam & Co. Its use prevents the annoyance caused by outside noises, which so much interferes with the distinct hearing of the voice upon the instrument. It also protects the ear from the painful sensation so often experienced after using the telephone, arising from the pressure of the receiver against the ear. We have tried a pair of the rings for a few days, and find them satisfactory.

ELECTRIC LIGHTING NOTES.

Belfast.—Owing to serious flooding on 15th inst. some of the premises in the High Street were deprived of their supply of current.

The head offices of the Belfast Banking Company are now lighted by four 3,000 C.P. arc and 72 incandescent lamps. Mr. J. H. Greenhill, of New King Street, carried out the wiring and fitting work.

Belgium.—Four firms submitted tenders for the concession for the electric lighting of the town of Tongres, viz., Messrs. Balant & Delvaux, Brussels; the Société du Phoenix, Ghent; the Compagnie Internationale d'Electricité, Liége; and Messrs. Bouckaert & Co., Brussels. They are at present receiving the consideration of the Municipal Authorities.

Brierley Hill.—The District Council is asking the Brush Electrical Engineering Company and the Town and Village Electric Lighting and Power Company, to meet the Lighting Committee—without charge—to furnish complete particulars regarding an electric lighting scheme, and the cost of same.

Broadstairs and St. Peter's.—Messrs. Poole & White, and the County of London and Brush Provincial Electric Lighting Company, having recently communicated with the Lighting Committee *re* electric lighting of the districts, have now been asked to attend—without any charge—a special meeting of the Council on 27th inst., and furnish explanations of their schemes.

Bury St. Edmunds.—The Town Council has decided to employ an expert to report upon the advisability of adopting electricity for public lighting, at a cost of not more than 50 guineas. Mr. Preece offers to do it for 50, and Mr. Medhurst for 25 guineas.

Cambridge.—The Cambridge Electric Supply Company, Limited, has applied to the Council for permission to erect poles to carry wires across Laundress Green and Sheep's Green to enable them to supply current to the Skating Ground in Grantchester Meadows. A committee recommended that consent be given, but the Council has referred the matter back.

Chelmsford.—According to the *Essex County Chronicle*, there was a sudden failure of the electric light on Sunday, 10th inst., some of the lamps being out all night.

Church Lighting.—The Vestry are so satisfied with the experiment of lighting Redcliffe Church by electricity, that they have now decided to permanently equip the church throughout with incandescent lamps, and for this purpose between 300 and 400 8-C.P. lamps will be required.

Coolgardie.—The *Financial News* says that an English syndicate has arranged to light Coolgardie with electricity by the middle of February, and will probably arrange to light Kalgoorlie at the same time.

Deptford.—We understand that Messrs. Drake and Gorham have been entrusted with the electric lighting of St. Paul's Church, Deptford.

Derby.—After going thoroughly into the expenditure upon the electric lighting undertaking, the Electric Lighting Committee state that to March 31st, 1895, it was £49,826. The amount borrowed amounted to £45,680, so that it has been found necessary to ask the Council to borrow £4,146 more.

Fulham.—The Vestry has appointed Mr. F. H. Medhurst to report upon electric lighting for the district and draw up a scheme forthwith.

Gloucester.—On 12th inst. the City Council decided to apply for a provisional order for public and private electric lighting.

Hampstead.—The Lighting Committee are to consider the advisability of extending the electric lighting mains from Heath Street to The Grove. It is complained by Vestrymen that since the current was switched on in certain streets, their telephones had been subject to continual disturbance, so as to render them almost useless.

India.—It is stated to be likely that during 1896 the theatre in the Simla Town Hall will be fitted up for electric lighting.

Llandrindod Wells.—It was stated at the last Council meeting that nothing definite had been arranged with Mr. Muller, of Birmingham, as to electric lighting, but the Clerk read communications which he had received from the Town and Village Electric Supply Company, desiring to tender for supplying the district with electric light. They proposed to lay down the necessary works and accept payment by annual instalment of from 20 to 40 years, with interest at 3 per cent. It was agreed that the Clerk should communicate further with the company on the subject.

London.—Mr. George Du Maurier has recently placed the electric lighting of his house in the Hyde Park district in the hands of Messrs. Rashleigh Phipps & Co. This firm has also just completed the lighting of St. John's Church, Paddington, where 200 lights have been installed with the greatest satisfaction to the vicar and churchwardens. Messrs. Treloar's and Messrs. Hudson Brothers' central depôts in Ludgate Hill have just been lighted by this firm, as also the Artists Volunteers' Headquarters, and they have carried out a very large extension of the lighting of the St. James's Theatre for Mr. George Alexander.

Lowestoft.—Speaking at the banquet to the retiring Mayor last week, the newly-elected chief magistrate (Colonel A. G. Lucas) voiced the generally expressed desire that this town should, before long, be supplied with the electric light, and he said he thought the time had arrived when the Council should seriously consider whether they should not take the initial steps. He pointed out that many small towns in Switzerland had made use of their water power, and he suggested that engineering science might enable Lowestoft to acquire sufficient motive power by means of the ebb and flow of the tide in the harbour.

Omnibus Lighting.—We are informed that Mann's Nottingham Horse and Carriage Company contemplate lighting their 'buses, both inside and out, by means of electricity. Current will be supplied from a battery under the driver's seat. The batteries will be charged from the Nottingham Corporation mains.

Oswestry.—A committee recommended the Council to introduce the electric light into the library and reading-room in consequence of the injury caused to the books by gas lighting. The matter has been referred back.—The agreement presented by the Town Clerk for the lighting of the Cross Market by electricity has been approved by the Council.

Provisional Orders.—According to notices in the *London Gazette*, the following provisional orders are to be applied for during the forthcoming session:—Liverpool Corporation, to supply electricity within the city, also for the repeal of the Orders relating to the Liverpool Electric Supply Company, Limited; Huddersfield Corporation, extension of area of supply by adding thereto the township of Longwood; Keswick Urban District Council, for the production, storage, and supply of electricity.

Messrs. S. & F. E. Andrews, of Pwllheli, Carnarvon, are applying for powers to lay down and maintain a tramway from the Maes to the New Esplanade, to be worked by steam, animal, electrical or other motive power. The Bexhill Water and Gas Company are applying for powers to produce and supply electricity, and to acquire the electricity undertakings of other companies, corporations, and persons. The City of Bath Electric Lighting and Engineering Company, Limited, are applying for a provisional order to supply electric lighting throughout the City of Bath. The company is at present a licensee under the Bath Electric Lighting License, 1890. The Guildford Gas Light and Coke Company are applying for various powers, including the production and supply of electricity for lighting and other purposes. The Burton-upon-Trent Corporation are applying for various powers, including the manufacture, sale, and hiring of apparatus and fittings for the use of gas and electricity.

Radcliffe.—The District Council has appointed a committee to consider the advisability of putting the powers obtained under their electric lighting provisional order into force.

Spain.—Tenders have just been invited for the concession for the electric lighting of the town of Cordova during the three years ending June, 1898. Work is about to be commenced on the construction of a central station at Santiago. Water power is being utilised.

Sunderland.—St. John's Wesleyan Church, Ashbrooke Road, is to be lighted throughout with 23 32-C.P. incandescent lamps.

Taunton.—The electrical engineer reports that the demand for the electric light is steadily increasing, and 140 16-C.P. lamps had been added during the quarter. The maximum load on the private lighting circuits was about 20 per cent. greater now than it was at the corresponding quarter of last year.

Torquay.—The Town Council had a discussion regarding electric lighting on 12th inst., the Electric Lighting Committee having recommended that the first report of the engineer consulted (Mr. W. Trentham), should be carried into effect. A committee of the whole council was appointed to go fully into the matter.

Train Lighting.—The new Pullman car train, which commenced running on the Brighton Railway on 4th inst., has a dynamo, &c., fitted in the brake van for supplying the electric light. All the cars are fitted both for compressed oil gas and for electric light, and are heated by means of hot water apparatus. Electric communicators are conveniently placed throughout, to enable passengers to summon the conductors when required.

The saloon carriage which has been constructed for the Duke of Sutherland's private train is lighted by electricity.

Wallasey.—The new ferry shelter at Seacombe is to be fitted up for electric lighting.

West Cowes.—Although steps have been in progress some time for electric lighting, a member of the Council moved, the other day, that the Gas Company be invited to tender for incandescent gas lighting, but it was no use, only two voted for his motion and it was lost.

Windsor.—The Thames Conservancy having declined to entertain the proposal to utilise the water-power at Windsor Weir for the purposes of electrical energy, the Town Council is trying to dispose of its provisional order, and tenders are at present being invited for it.

Woking.—The Lighting Committee considered the decision of the St. John's ratepayers regarding the estimate of Messrs. New & Mayne and Mr. Woodridge regarding the cost of lighting St. John's by electric light and oil, and the Council, after discussing the matter, resolved to obtain tenders for lighting St. John's Ward by electricity, gas, and oil.

Wolverhampton.—On 18th inst., there was a failure of the electric light. The Council Chamber was thrown into darkness while the Council was sitting, and the gas had to be lighted.

Yarmouth.—The last monthly statement shows that the receipts were £245 12s. 11d., yielding an excess over the cost of production of £104 5s. 5d. From this has to be deducted repayment of capital, interest, depreciation, &c., amounting to £85 or £90 per month. Applications have been received from nine more customers for 302 lamps, making a total of 120 customers, using 5,789 lamps. The cables are to be extended to Langham and Euston Roads, and the east side of the Market Place. Mr. W. H. Preece recommends that, in view of the rapidly increasing demand for the light, it would be advisable to put in the additional boilers and dynamos in time for the next winter supply; that instead of two 150-H.P. boilers, two 200 H.P. boilers should be put in, and that instead of three 75-kilowatt dynamos, two 150-kilowatt dynamos be put in. This will increase the capacity of the station from 13,500 lamps to 15,750 lamps, without counting the gas engine, and the cost will not exceed the amount of the loan sanctioned.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast Tramways.—Parliamentary notices are to be lodged during the next Session in order to enable the Belfast Street Tramway Company, if they secure the necessary powers, to use electricity as a motive power for their tramways. The system which the company intend to adopt is the overhead.

Derby-Ashbourne Proposed Tramways.—Notice is published in the London *Gazette*, and in the *Derbyshire Advertiser and Journal*, of the application to be made during the ensuing Parliamentary session for the incorporation of a company, and powers to construct and maintain tramways worked by electrical power. The various usual incidental powers, *re* generating stations, &c., are sought by the promoters.

Electric Elevators.—The following details regarding electric elevators which have been erected by the Otis Elevator Company are exceedingly interesting. We understand this company has in daily working about 4,000 such elevators, and is adding to this number every week. In London the company has fitted them at the following addresses:—

1, Hyde Park Gate, current taken from the mains of the Kensington and Knightsbridge Company.

4, Carlton House Terrace, current taken from the mains of the Charing Cross and Strand Electricity Supply Company.

Suffield Chambers, Davies Street, current taken from the mains of the Westminster Electric Supply Corporation.

68, South Audley Street, current taken from the mains of the Westminster Electric Supply Corporation.

Gordon Mansions, Gower Street, two passenger elevators, current taken from the mains of the St. Pancras Vestry.

Chelsea (for Peter Jones), current taken from the mains of the Chelsea Electricity Supply Company.

21, Old Bond Street (for Duveen Brothers), current taken from the mains of the Westminster Corporation.

Also in Brighton, Sunderland, and Edinburgh, as well as various Continental towns, there is a number of electric lifts being erected, one special instance being a Berlin building, which is being fitted with twelve large elevators. In many cases, hydraulic elevators of modern types are being replaced with electric elevators, a number of such instances having occurred at Paris, and one at Glasgow. The heavy working cost of the hydraulic lifts has led to the change in favour of the electric, the Otis elevator having acquitted itself very satisfactorily in this respect.

Electric Boat.—An experiment has taken place on Loch Tay with an electric boat. It is an ordinary keel boat, 16 feet in length, and was purchased by Mr. John Macdonald, Beechwood Cottage, Strathtay, who fitted it up with his "patent" electrical boat gear.

Electric Traction in Japan.—A project has been prepared, and is at present receiving consideration, for the construction of an electric tramway between the towns of Uraga and Tokosuka, Japan.

Electric Traction in Belgium.—It has just been decided by the Société Nationale des Chemins de Fer Vicinaux to adopt electric traction on its railways in the Centre and Charleroi districts of Belgium.

Electric Traction in Austria.—We hear that not a single English firm responded to the recent invitation for tenders for the establishment of a system of electric tramways in Vienna. Seven tenders, in all, were submitted, these being from the leading Austrian and German concerns.

Electric Traction in Spain.—Plans have been prepared, and application made for a concession for an electric tramway between the Plaza de Oriente in Madrid and the suburb of Abronigal.

Electric Traction in Germany.—The Allgemeine Electricitäts Gesellschaft, of Berlin, is about to commence the construction of an electric tramway in the town of Tilsit. A further line of electric tramway, known as the Bayerstrasse-Giesingerberg line, has just been opened for traffic in Munich. It is proposed to construct a system of electric tramways in the town of Darmstadt. Plans have been prepared for an electric tramway between Ziegenruik and Possneck.

Electric Traction in France.—Plans have been prepared for an electric tramway between Charleville, Meziers, and Mohon (Ardenne). A company has lately been formed in Paris, with a capital of £60,000, to be known as the Compagnie du Tramway Electrique de Paris à Romainville. It is reported that negotiations are in hand for the conversion of the tramways of the Compagnie des Tramways de Paris et du Departement de la Seine into electric lines.

Halifax Tramways.—A Bradford paper says:—"A scheme for laying down and working electric tramways in the Halifax district is about to be put forward by a syndicate of gentlemen interested in similar undertakings. Messrs. Land & Foster are the solicitors, and the preparation of the plans is in the hands of Messrs. Utley & Gray, surveyors and architects."

Kidderminster and Stourport Electric Tramway.—During the ensuing Session of Parliament, application is to be made for the authorisation of a company to construct and operate, by means of electrical power in addition to, or substitution for, animal power, from Vicar Street, Kidderminster, to Bridge Street, Stourport. A single line is proposed, except for certain points. Another line, proposed by the same promoters, will run from Spirit Lane, Shortheath, to the Bridge Streets of the above line. A third suggested line will run from New Road, Kidderminster, to the Canal Basin of the Staffordshire and Worcestershire Canal. Various incidental powers are petitioned for.

Leeds Electric Tramways.—Some criticisms having been circulated regarding the engagement of Dr. John Hopkinson as consulting engineer in connection with the electric tramway extensions to be carried out here, a member of the City Council the other day moved that the minute with reference to Dr. Hopkinson's appointment be referred back. Statements were made as to his being interested in special systems, but this was denied by him in a letter to Alderman Firth. His appointment was confirmed by a large majority.

Light Railways.—A conference is announced to be held at Westminster Palace Hotel on 28th inst., Sir A. K. Rollitt, M.P., presiding, for the purpose of discussing the furtherance of legislation in regard to light railways. It has been decided to take the Bill introduced by the late Government as a basis of discussion.

Subways at the Mansion House.—The City Commission of Sewers have had under consideration an application by the Central London and Waterloo and City Railway Companies to make certain modifications in the design of subways in connection with the central station about to be constructed at the Mansion House. The Commission consider certain proposals highly objectionable, and have refused their sanction to them. In regard to the whole scheme, the Commission, before giving permission to commence any of the works, are requiring the Central London Railway Company to satisfy them as to their ability in every respect to complete the station, subways and approaches in conformity with their Act.

The Brighton and Rottingdean Railway.—At a special meeting of the Brighton Town Council, held on Saturday, it was resolved: "That the application of the Brighton and Rottingdean Seashore Electric Tramroad Company for permission to erect 13 tubular poles, 80 yards apart, on the foreshore between Passion Place Jetty and the borough boundary at Black Rock, for the purpose of carrying an electric trolley line, be, and is hereby, granted, provided that the company pay a rental of £1 per annum, and enter into a bond for £1,000, with two approved sureties, to remove the poles within three months after the receipt of a notice from the Corporation, and also to remove the rails and concrete blocks in the event of the line being abandoned, or not worked for a period of six months." Mr. Volk, in reply to questions, said he was responsible for the position of the poles; but as he had not had experience in putting up poles, he referred the matter to Mr. Dawson, the company's consulting electrical engineer. Mr. Dawson had put up many miles of trolley line, and he assured him that the wires could be safely worked with the poles 80 yards apart. After Mr. Dawson had answered several questions, the resolution was put and carried.

TELEGRAPH AND TELEPHONE NOTES.

Cables for the Ashanti Expedition.—The telegraphic battalion accompanying the forces to Ashanti will take out a cable, and it is expected, according to the *Times*, that the wire to Prahsu will be laid in 12 days. Part of the 75 miles will be cable, and at other sections air lines will be put up.

Canadian Telegraphs.—A *Times* despatch from Ottawa says that the Government is negotiating for the extension of the telegraphic service to Belle Isle, *via* Bonne Bay, Newfoundland. The line will be a great benefit to the shipping interests, as it will enable vessels from England to be reported the fourth day out.

Interruption.—We learn that cable communication with the East is interrupted, and we have heard it rumoured that the recent extensive floods in the Caucases have swept away the land lines there.

Norwich Telephone Service.—The National Telephone Company has been engaged during the past twelve months in effecting improvements in the local telephone system. The alterations are now completed, and were put into operation on Monday last, when the company moved into its new premises. The call-wire system has been introduced. Early in 1896 the trunk wires are to be extended to Norwich.

Stroud Telephone Service.—The National Telephone Company have just opened an exchange at Stroud. A company numbering about 40 were entertained to luncheon by the directors of the company on the 18th inst.

The Telegraph Wire Export Trade.—Judging from the returns which are now available regarding the export of telegraph wire, and apparatus connected therewith, from this country during last month, no improvement can as yet be recorded in this branch of industry, seeing that the value of the exports only reached a total of £39,769, as compared with £45,268 in September. The returns, however, are slightly better than those for October, 1894, when the amount was only £22,262. The great falling off which has taken place in this trade is well illustrated by the figures relating to the exports during the 10 months ending with October last. During the period named they only amounted to £423,206, as against £1,326,856 in the corresponding period of last year, and £1,012,305 in the first 10 months of 1893.

The Queensland Telegraph Department.—The annual report of the Post and Telegraph Department of Queensland, for the year 1894, states that there are now 9,986½ miles of line and 17,801 miles of wire open for public business. At the close of 1894 there were 362 stations in daily operation; six new stations had been opened and three closed. During the year, in the Southern and Western districts, there have been 546 interruptions to communication, the average duration being 18 hours; 108 for less than 1 hour; 148 for more than 1 hour and less than 3 hours; 80 for more than 3 hours and less than 6 hours; 47 for more than 6 hours and less than 12 hours; 69 for more than 12 hours and less than 24 hours; 61 for more than 1 day and less than 2 days; 23 for more than 2 days and less than 7 days; 10 for more than 7 days. In the Northern district the total number of interruptions was 271, varying in duration from a few moments to 577 hours. The number of messages transmitted and received (including international) amounted to 991,773; the value of ordinary messages transmitted (excluding O. H. M. S., value £9,083 19s. 10d.) was £67,416 9s. 7d., and the revenue paid to treasury (including £4,679 5s. 1d. on account of telephones) £72,159 19s. The receipts showed a falling off of £9,044 as compared with 1893. The cost of construction to date (including buildings) was £845,334 1s. 9d. The report further states that "In the practical application of electricity in its various forms great advances have been made of late years, and the necessity of procuring the assistance of a thoroughly trained electrical engineer to advise the department upon the general telegraph system of the colony, its economical working, and the facilities that may be thereby afforded for its extension to places not now served, as well as to protect the public interests upon such important matters as electric lighting and electric motive power, has forced itself strongly upon my attention, and it is now proposed to ask Parliament for the necessary authority for supplying this urgent need."

The Pacific Cable.—A private interview took place at the Colonial Office on Tuesday, between Mr. Chamberlain and the Agents-General for the Australian colonies, for the purpose of discussing the suggested Pacific cable which shall pass entirely through British territory. Among those present were Sir Charles Tupper (High Commissioner for Canada), Sir Saul Samuel (New South Wales), the Hon. Thomas Playford (South Australia), Mr. Charles S. Dicken (Queensland), Mr. Spencer Brydges Todd (the Cape), Mr. Walter Peace (Natal), the Hon. Duncan Gillies (Victoria), and others. The interview lasted about half-an-hour, and at the close a representative of the Exchange Telegraph Company was officially informed that Mr. Chamberlain had said that such a meeting was, in a sense, a meeting of the Council of the Empire, brought together for the purpose of common interests; and that the presence of the representatives of the Cape and Natal, who were not concerned in the project in its present form, was an evidence of solidarity and sympathy. He expressed his opinion that the project showed a very fair prospect of remunerative return on the capital required, and his willingness to join in the formation of a joint commission which should report upon the subject. He also suggested that the commission should consist of representatives of Great Britain, Australasia, and Canada. After some discussion it was arranged that the colonial representatives should be named by the Colonial Office and appointed by the Imperial Government, and that the Commission should consider and report on the whole subject in all its aspects; and it was understood that the Agents-General and the High Commissioner for Canada would move their respective governments to appoint representatives on this understanding.

Taunton Telephones.—At Taunton, on Monday, the National Telephone Company opened a new exchange.

The Telephone in Yorkshire.—On Wednesday, at the General Post Office, a deputation from the West Riding of Yorkshire waited on the Postmaster-General to urge upon him the necessity for increased facilities in telephonic communication in Yorkshire. The deputation, which was accompanied by Mr. Arnold, M.P., Mr. T. P. Whittaker, M.P., and Mr. D'Arcy Wyvill, M.P., consisted of the Presidents of the Chambers of Commerce of Leeds, Huddersfield, Halifax, and Keighley, and other gentlemen from the West Riding. Mr. Arnold, M.P., said he wished to emphasise the fact that in the part of Yorkshire which they represented there was a very large manufacture of soft goods carried on. The material, in the process of its manufacture, had to go to different towns in the West Riding, so that between these different towns there ought to be absolute freedom of communication as an essential thing. To secure this end he would advocate an increase in the number of trunk wires and the uniting of the various towns which they represented in one telephonic area. Mr. Slater (Leeds) also urged the necessity of extending the system of trunk wires, and the bringing of the various towns into one area, and said that it would be a very great advantage to the traders in these towns which they represented if those improvements were conceded by the Postmaster-General. Mr. Alderman Firth (Halifax), Mr. A. Walker (Huddersfield), Mr. Greenwood (Keighley), and Mr. D'Arcy Wyvill, M.P., addressed the Postmaster-General to the same effect. The Postmaster-General, in his reply, said that he should only be misleading them if held out hope of being able to accede to the first request. The areas had all been specified and drawn up carefully, while the deputation asked that they should all be thrown into one. The authorities were anxious to do all they could in the direction of increasing the number of trunk wires, but even if everything was granted that was asked for, there were limits to the perfection that was attainable.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackburn.—November 30th. The Corporation invite tenders for alternators, transformers, switchboards, &c.

Belgium.—January 15th, 1896. The Belgian Minister of War is inviting tenders for the contract for an installation of electric lighting in the new military school in the Avenue de la Renaissance in Brussels. Tenders to the Ministère de la Guerre, Brussels.

Cardiff.—November 28th. Tenders are invited for the electric lighting of the new technical schools in course of erection. Particulars on application to the secretary, College Buildings, Dumfries Place, Cardiff.

Chili.—December 5th. Tenders are invited for the manufacture and laying of a submarine telegraph cable from Puerto Montt to Punta Arenas. The conditions and specifications may be consulted in the Chilian Legation, Member's Mansions, 36, Victoria Street, S.W.

Durban.—November 27th. Tenders are at present being invited for No. 40 cast-iron service-boxes for connections from concentric mains, No. 120 cast-iron service-boxes (or handholes) for house connections, No. 60 cast-iron junction-boxes for arc lamps, No. 70 east-iron manhole frames and covers, and No. 60 ornamental cast-iron arc pillars, 25 feet high, for the Corporation of Durban. Details from the consulting engineer, Mr. W. H. Radford, C.E., Pelham Chambers, Nottingham, on deposit of £2 2s. Tenders to be delivered in London by 27th inst.

France.—November 28th. The General Direction of the French Posts and Telegraphs is inviting tenders until the 28th inst., for the supply of 46,280 telegraph poles, in eight lots. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Handsworth.—November 26th. Tenders are invited for an installation of fire-alarms to firemen's house and telephonic calls to out-stations, for the Urban District Council. Plans and specifications may be seen at the Surveyor's Offices, Council House, Handsworth.

Manchester.—December 2nd. The Corporation invites tenders for two dynamos for the Foreign Animal's Wharf, Mode Wheel. Particulars from the City Surveyor, Town Hall.

Swansea.—December 6th. Tenders invited for supply and erection of plant for electric lighting and dust destruction for the Corporation.

Windsor.—January 1st, 1896. The Corporation invites proposals for taking over and working their electric lighting orders. All proposals to include the erection and maintenance of a generating station upon a specified site, laying down mains, and necessary equipments, with a constant supply of electricity for lighting purposes in the stated area. Details to be obtained from the Town Clerk, Windsor.

Warrington.—November 30th. The Cheshire Lines Committee invite tenders for the supply, during the year 1896, of various stores, among which are the following items:—Iron bars, sheets and plates, spike iron, &c.; telegraph materials, instruments, wire, &c.; wrought-iron tubing, point rodding, point rollers and standards, lead piping, and sheet lead; wrought-iron bolts, chain, &c.; galvanised sheets, signal wire, pulleys, stay-rods, screw-spikes, zinc sheets, &c. Particulars from Mr. Saxon Barton, storekeeper, Cheshire Lines, Warrington.

York.—November 26th. The North Eastern Railway are prepared to receive tenders for telegraph apparatus and telegraph wire and line stores in such quantities as they may require, during the six months ending June 30th, 1896, delivered carriage paid at the company's telegraph stores at York. Particulars on application to Mr. Graves, Telegraph Department, York.

CLOSED.

Brompton.—The following tenders were sent in for electric light wiring and fittings for the Committee of the Cancer Hospital, Brompton, S.W. Mr. Morgan Williams, Assoc. M.Inst.C.E., Consulting Engineer.

Name of firm.	Wiring.	Cutting away and making good.	Fittings, exclusive of lamps.	Totals.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Crompton & Co.	668 0 0	45 0 0	107 8 0	820 8 0
Rashleigh, Phipps & Co. ..	533 0 0	20 0 0	115 5 6	658 5 6
H. M. Leaf	330 0 0	25 0 0	99 11 6	454 11 6
Drake & Gorham (accepted)	309 0 0	25 0 0	86 19 0	420 19 0
Sotheby & Co.	293 10 0	26 10 0	77 14 0	397 14 0

Cheltenham.—The Council has accepted the tender of Messrs. Siemens Bros. & Co. for a switchboard at £165 and regulating resistance at £12 10s. The Electric Lighting Committee was asked if it would light the new Lecture Hall at St. Andrew's Church and the Church itself by electricity at the figure it had cost for gas lighting, but the Council decided not to entertain the proposal. Alderman Norman reported the total applications received for current as 4,540 8-C.P. lamps and the number wired 4,134, an increase of over 1,000 wired since the last Council meeting. He stated that "from the beginning until now the Committee had never had a moment's anxiety at the station or in connection with the machinery."

Saltash.—The following tenders were recently sent in for lighting with electricity, gas, and oil, the public lamps of the borough for the Saltash Town Council:—T. Martin (electricity), 7, Carlisle Avenue, Plymouth (accepted), £2 10s. per lamp for 12 months; J. Cowdy (oil), Queen Street, London, £3 0s. 6d. per lamp for 12 months; Saltash Gas Company, Saltash, £2 10s. per lamp for 12 months. This latter company did not comply with conditions; if kept to the cost would have been about £3 15s. per lamp for 12 months.

Shoreditch.—The tender of Messrs. Manlove, Alliott and Co., amounting to £1,944 14s., for the ironwork of the electric lighting station buildings not in their previous contract for the dust destructor, has been accepted by the Vestry.

Tunbridge Wells.—From the tenders sent in for the supply of brackets to be attached to the arc lamp-posts, for the Lighting Committee, that of Mr. Every at 17s. 9d. each has been accepted.

ELECTRIC LIGHTING REGULATIONS.

Sir Courtenay Boyle, the Secretary of the Board of Trade, opened a conference on Tuesday last on the suggested revised regulations for electric lighting. Most of the principal companies and corporations were represented by their engineers; the Institution of Electrical Engineers was represented by Prof. Ayrton and Mr. R. E. B. Crompton, Earl Russell appeared for the County Council, Mr. Musgrave Heaphy for the Phœnix Fire Offices, and Mr. D. Sinclair for the National Telephone Company. The chairman was accompanied by Mr. W. H. Preece, C.B., Major Cardew, Sir Thomas Blomefield, and other officials of the Board of Trade.

The Chairman said that as it was considered necessary to revise the regulations, it was thought desirable to invite the representatives of the industry to discuss the various clauses, and suggest alterations. After the conference, the Board of Trade would issue revised regulations, without publishing any further draft. It had been intended to make the regulations retrospective, but objections to this would be carefully considered.

The meeting then proceeded to discuss the definitions and clauses *seriatim*.

To make the observations clear, it will be more convenient to reproduce the definitions and clauses, with some of the objections sent to the Board of Trade:—

Definitions.

In the following regulations:—

The expression, "the order," means the order.

The expression, "the undertakers," means the undertakers for the purpose of the order.

The expression, "consumer's wires," means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression, "aerial line," means any electric line which is placed above ground and in the open air.

The expression, "pressure," means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; pressure on any alternating current system being taken to be the equivalent of pressure on a continuous current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and—

(*a*) Where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts, if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low pressure supply.

(*b*) Where the conditions of the supply are such that the pressure may exceed the limits of a low pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply.

(*c*) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, or the equivalent of 3,000 volts, the supply shall be deemed an extra high pressure supply.

Mains, service lines, and other conductors and apparatus, are referred to as low pressure, high pressure, and extra high pressure mains, &c., according to the conditions of the supply delivered through the same, or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the order, or principal Act, have the same respective meanings in these regulations.

The definition, "Pressure" (*a*), in conjunction with Regulation 1, had called forth a good many objections:—

The Notting Hill Electric Lighting Company, Limited—300 *volts* should be increased to 600 *volts*.

The Dover Electricity Company contended that the pressure should be raised to 440 volts for continuous current, and 220 volts for alternating current.

The Institution of Electrical Engineers—Wording of definition of pressure between two conductors to be amended to make matters clearer [*no amendment suggested*]; and maintained that—Wording to be made clear that with three-wire system 200 to 250-volt lamps may be allowed. Voltage should be raised to 600 volts continuous, and equivalent of 500 volts if alternating. Support general desire of the profession to use glow and incandescent lamps taking from 200 to 250 volts at their terminals.

The Manchester Corporation urged that Manchester be exempted from operation of new regulations so far as the system (a five-wire system) is concerned (hitherto defined as a low pressure system), or that the definition of high pressure and low pressure may be so modified as to continue Manchester as a low pressure supply, to apply to all future extensions of the five-wire system in Manchester.

The following discussion then took place:—

Mr. Crompton urged the desirability of increasing the low pressure limit to one of 600 volts. Such a pressure would do much to simplify systems of distribution and cheapen the cost of supply. He pointed out that there was no very great danger to human life at such pressure. He had frequently received shocks at that pressure with no ill effect.

Mr. Siemens and Prof. Kennedy followed on the same lines.

Dr. Hopkinson, who appeared for the Manchester Corporation, said if the pressure limit were not raised, it might involve the Manchester Corporation in a great hardship.

Mr. Alderman Higginbottom, of Manchester, mentioned that the Board of Trade had on two occasions approved of the Manchester system as a low pressure one.

Earl Russell, who appeared on behalf of the London County Council, said that while the County Council would object to the introduction of 300 volts in houses, they were not averse to an intermediate class of pressure between that in (*a*) and (*b*).

Prof. Ayrton pointed out that it was not clear whether the regulation referred to any two conductors whatever in a system, or to the adjacent wires in a three or five-wire system. He considered that the introduction of 250 volts in a house was safe, but that would, on a three-wire system, mean 500 volts between the outside mains. He should propose that the rule be modified and read thus: "The expression 'pressure' means the difference of electrical potential between any part of any conductor and the earth, or between any two adjacent wires on the three or five-wire systems."

The Chairman said the Board of Trade would be prepared to consider this.

Major Cardew spoke of the danger of increasing the pressure on bare copper mains. He doubted whether consumers would recognise the advantage of 200-volt lamps. At the same time, he thought the question of raising the limit of an alternating current was worth considering.

Sir Courtenay Boyle said he should advise the Board of Trade to raise the alternating current limit from 150 to 220. His own feeling with regard to continuous current was, that it might be raised slightly above 300 volts.

The first clause, "Save as hereinafter provided, the supply of energy delivered to the consumer's terminals shall be a low pressure supply," was then passed.

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2. "A high pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high pressure supply may be given to distributing or converting stations, or to transforming apparatus on a consumer's premises, in accordance with the following regulations."

A slight alteration was suggested by the Southport Corporation.

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3. "An extra high pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe."

No observations were made.

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4. "No high pressure electric line shall be used for the transmission of more than 200,000 watts, or in the case of an aerial line, 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded."

Observations made to the Board were that this was much too low. The suggestion made was that it should be 500,000.

After considerable discussion the Chairman said that 200,000 watts was too low, and he should advise the Board of Trade not to adhere to it. At the same time he thought 500,000 watts too high.

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5. "Every high pressure electric line, conductor, or other apparatus, shall be protected by a suitable automatic quick-acting cut-off."

The British Insulated Wire Company, Limited, advised that some directions should be inserted for the guidance of undertakers using a system in which the outer conductor is connected to earth. Quote cases in which, on such a system, a fuse has been used on each conductor, and, owing to weakness of the fuses or an overload, the fuse on the outer has gone, and the outer conductor of the cables and transformers or machine has been charged up to the full working potential above that of the earth, with consequent damage to the insulation.

After discussion, the Chairman announced that the Board of Trade were prepared to amend this regulation by the insertion of words necessary for the guidance of undertakers.

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6. "In every case where any transforming apparatus is used to convert a high pressure supply into a low pressure supply, some suitable automatic and quick-acting means shall be provided to protect the low pressure system from any accidental contact with or leakage from the high pressure system, either within or without the transforming apparatus."

Among the observations, it was questioned whether such automatic means are really needed when earth-shielded transformers and earthed metallic shielding between H.T. and L.T. conductors are everywhere employed, and also that in the absence of any known suitable device of the kind described the clause should be omitted.

After discussion, the Chairman said the objections should be carefully considered.

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7. "The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30° F.; and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time; and special care shall be taken that the cross sectional area and conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion."

The Institution of Electrical Engineers suggested to omit "or in any case to raise such temperature to a greater extent than 30° F., and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time."

The suggestion of the Institution of Electrical Engineers was accepted, and the rule will stand minus those words.

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8. "The sectional area of the conductor in any electric line laid or erected in any street shall not be less than the area of a circle of $\frac{1}{10}$th of an inch diameter, and when the conductor is formed of a strand of wires, each separate wire shall be at least as large as No. 20 standard wire gauge."

It was suggested that after "electric line" insert "hereafter."

It was agreed not to make this retrospective.

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9. "Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance less than at the rate of 100,000 ohms per mile for every volt of pressure of the supply, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than 10 megohms."

This clause had evoked a good many observations. Among them were, that low pressure service lines should not be included in the regulation.

That whenever the cable for service lines has been tested on the drum, it should not be necessary to again test the separate lengths when cut off. The apparatus would be costly and cumbersome for street use.

The regulation as it stands would prevent the employment of bare copper systems, as in use at Preston, which work perfectly well in practice. Their insulation does not reach the required figures, but the company have had no trouble therefrom.

The 200-volt testing pressure is unusual, and will tend to upset present arrangements. The usual testing pressure is only 100 volts, batteries being arranged in sets for the purpose.

After a good deal of discussion, the Chairman said he was prepared to amend this clause by leaving out everything after "test of each line or section of line." This evoked considerable applause, and Prof. Ayrton thanked the chairman for his extremely liberal offer.

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10. "The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not, under any conditions, exceed one-thousandth part of the maximum supply current, and suitable means shall be provided for the immediate indication and localisation of faults of insulation. Every such fault shall be remedied without delay.

"Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of such testings.

"Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to such circuit, so long as such connection exists."

Many objections were raised against this clause. Some of them were as follows:—

On low tension mains tests at much longer intervals than a week are sufficient.

To maintain the insulation at the standard mentioned may involve much interference with consumers' installations, over which the undertakers have no effective power, especially if the low figure of 5,000 ohms is retained in Clause 45.

Question how leakage current is to be distinguished from displacement or capacity current in alternating current systems. A few miles of high pressure mains give a capacity current measurable in ampères with the frequencies in general use.

Impossible to provide apparatus for the immediate localisation of faults of insulation.

Submit that regulations should provide that circuits may be tested for insulation by testing the leakage current to earth.

Inapplicable to an alternating current system, since the condenser current on long lines is much more than the minimum specified, and is practically undistinguishable from leakage current.

Clause does not say how the leakage current is to be ascertained; it is presumable by earthing either conductor, and noting amount of current passing. Ask if such an earth connection is to be allowed.

But in conjunction with Clause 45, undertakers might be compelled to make supply to any consumer having an insulation resistance above 5,000 ohms.

If such an insulation resistance become at all general, the leakage current from this source alone would greatly exceed that allowed by Clause (10).

Ask if undertakers have authority to insist on an insulation resistance in excess of 5,000 ohms.

A good deal of discussion followed.

Dr. John Hopkinson suggested that instead of the leakage current being one-thousandth part, it should be one two-hundredth part.

Many remarks were made to the effect that the testing was too frequent.

Mr. Preece said the chief trouble they had to face was that of cheap work, also that they could not secure control of the consumer's house. At the same time, he could not conceive it possible that any well-conducted enterprise should have any difficulty in securing a proper test once a week. He urged very strongly that this clause should be retained.

The Chairman said the objections would be considered.

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11. "All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal."

Last sentence of Regulation 12 should be transposed to this regulation.

Sir Courtenay Boyle accepted the transposition of the sentence, which was a misprint.

Mr. Crompton protested against the last sentence of this clause in its amended form. He considered it experimental.

Another speaker said he had used it for years.

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12. "Every high pressure conductor shall be continuously covered with insulating material to a thickness of not less than $\frac{1}{10}$th part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. If this protection be wholly or partly metallic it shall be efficiently connected with earth."

(Last sentence should follow on previous clause.)

The observations were:—If regulation will apply to existing high pressure wires, Corporation will have to remove all their high pressure conductors (which are 7/16s.) and all the electric lines between them and the transformers.

Suggest that clause should not apply to existing high pressure conductors belonging to works already provided.

Can specify minimum insulation of $\frac{1}{10}$th of an inch for all future extensions.

Minimum thickness of $\frac{1}{10}$th inch of insulating material is in the case of small cables unnecessary, and that the quality of the insulating material should be taken into account as well as the thickness.

Minimum insulation resistance specified is excessive for small conductors. A large proportion of Company's cable has a less thickness of dielectric, but it is of the best quality vulcanised rubber, and is further protected with insulating tape, &c.

Mr. Robert Hammond said that this clause ought not to be made retrospective. It would be a great hardship to old companies if the word hereafter was not inserted. He considered the thickness did not take into consideration the quality of the material.

Mr. Wilkinson, of Eastbourne, asked that the clause should not be retrospective.

After further discussion, Sir Courtenay Boyle said he was prepared to advise that the regulation should be made prospective with only this provision, that if any defects are discovered by the absence of the regulation, the rule in this case should be made retrospective.

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13. "No electric line, machine, device, or apparatus, intended to form part of, or be connected with, a high pressure circuit, shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use.

"The undertakers shall duly record the results of such test."

The observations on this clause were fairly numerous.

Bournemouth and District Electric Supply suggested that if this is to be applied to the outer insulation of a concentric cable, what fraction of the working pressure between the two conductors is to be taken as the working pressure between the outer conductor and the earth.

Point out that the outer conductor under normal conditions takes very nearly earth potential, but under occasional accidental circumstances may be exposed to the full working pressure.

Bolton Corporation said if the regulation is retrospective, it would cause great inconvenience, and possibly breakdown, to test all their existing high pressure plant with 4,000 volts for one hour.

House-to-House Electric Light Supply Company, Limited, considered it would be running a great risk to double the voltage required in some instances, such as alternators.

The Institution of Electrical Engineers suggested the omission of the words machine or device.

In the discussion that followed, Prof. Kennedy thought that the word machine ought to be omitted.

Mr. Albert Gay said that it would be impossible to apply the clause to an alternator; the machine would be unnecessarily strained. He thought 25 per cent. above the working figure would be ample.

Mr. Robert Hammond suggested that 50 per cent. above the working conditions could be met.

Mr. Crompton said the failure of a machine in a central station would not affect the public.

After further discussion, the Chairman said he was prepared to recommend that it should be twice the pressure in the case of lines, but 50 per cent. in the case of machines and apparatus.

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14. "Where any portion of any electric line, or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury."

No observations were made on this.

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15. "Where any accident by fire or explosion, or any accident causing, or likely to have caused personal injury, occurs at any part of any electric line or work to which these regulations apply, the undertakers shall give immediate notice thereof to the Board of Trade."

Observations on this were to the effect that the regulation should be revised so as to provide that only accidents causing, or likely to cause personal injury, should be reported.

Blackburn Corporation—The wording is too general, and might include any petty mishap.

The speakers urged that the clause would mean the reporting of every trivial accident. After further discussion it was agreed that the words, fire or explosion, should be left out.

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16. "Every aerial line shall be attached to supports at intervals not exceeding 200 feet where the direction of the line is straight, or 150 feet where this direction is curved, or where the line makes a horizontal angle at the point of support."

No observations were made.

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17. "Every support of aerial lines shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the lines, or unequal lengths of span. The factor of safety for the lines and suspending wires shall be at least six, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 lbs. per square foot. No addition need be made for a possible accumulation of snow.

"Every support, if of metal, shall be efficiently connected with earth."

No observations were made.

18. "Aerial lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by metal binders."

London Chamber of Commerce suggested that the word "uninsulated" should be inserted before "metal binders."

This was accepted.

The conference then went on to consider rules as far as 27. The discussion will be given next week, as well as the proceedings of the following day. In opening Wednesday's proceedings, Sir Courtenay Boyle said, with regard to the discussion which took place on Tuesday as to the definition of "low pressure," he had come to the conclusion that it would not be possible for him to give definite and final advice to the Board of Trade on the subject, and, therefore, he suggested that those interested in the question should reserve the decision for a short time, and that the Board of Trade should appoint a small committee of expert advisers to carefully consider the scientific aspects of the question and make suggestions to the Board of Trade.

The remainder of the rules were discussed, and the meeting of the conference terminated on Wednesday afternoon.

NOTES.

Lectures and Papers.—In a forthcoming paper, to be read before the Liverpool Architectural Society, Mr. T. L. Miller will deal with "The Application of Electricity to Lighting and Power Purposes."

At Toynbee Hall last Saturday, Prof. Silvanus P. Thompson lectured on "The Magnetic Effects of an Electric Current."

Before the Newcastle Association of Engineer Students on 12th inst., the Hon. C. A. Parsons delivered his presidential address, which was devoted to "The Application of Electricity to Practical Purposes."

At the meeting of the Northern Society of Electrical Engineers at the Palatine Hotel, Hunt's Bank, Manchester, on Monday, November 25th, 1895, a paper will be read on "The Use of Dust Destructors as Steam Producers for Electricity Supply Stations," by Mr. E. Manville.

Before the Royal Society yesterday afternoon, a paper was read by Mr. G. J. Burch on "The Calibration of the Capillary Electrometer." An extra meeting for the reading of papers will be held on November 28th. The anniversary meeting will be held on Saturday, November 30th, at 4 p.m.

Next Wednesday (November 27th) at 8 p.m., before the Society of Arts, a paper on "Locomotive Carriages for Common Roads" will be read by H. H. Cunynghame, Sir Frederick Bramwell, Bart., D.C.L., F.R.S., presiding.

At next Tuesday's meeting of the Institution of Civil Engineers, the paper on "The City and South London Railway: Subaqueous Tunnelling by Shield and Compressed Air," by Mr. James Henry Greathead, M.I.C.E., will be further discussed.

At the Plymouth Technical Schools on 17th inst., Mr. W. A. Douglas Rudge lectured on "Warming and Lighting," and introduced to his audience some of Crompton's electric heating and cooking apparatus.

Magistrates and Horseless Carriages.—Mr. Joseph Wright, of Argyle Street, Glasgow, recently inquired the opinion of the Magistrates' Committee there, as to whether he would be allowed to run a horseless carriage in the streets of the city. The magistrates, after careful consideration, came to the conclusion that such a carriage was liable under the Locomotive Acts, and permission could not therefore be legally granted. He would not be entitled to run a horseless carriage unless he complied with the conditions laid down in those Acts. It may be as well to take such opinions, but to actually contest the law upon the point would seem to us to be waste of both time and money. The wiser course now that the Press and the public understand the absurd stipulations of the law, would be to centre all energies upon getting a new Act passed at the earliest possible moment, and thus avoid the controversy and consequent delay which will undoubtedly arise if attempts are made to squeeze horseless carriages in under the existing Acts. Fresh legislation, and that alone, will mend the situation effectually, and we believe the Government will not long delay the passage of remedial measures. Meanwhile, we maintain that it is useless to contest the question further.

Sad Fatal Accident from Shock in America.—The *Western Mail* for 18th inst. states that the administration of the electrical plant of the city of Wheeling, in America, recently changed hands, and the transfer was marked by one fearful accident, that proved fatal, and another in which the victim had a narrow escape from death. Christopher Scheehle was the new lamp trimmer on the Island circuit. A little before 7 o'clock, to get an early start, he shouldered his bag of tools and started to work. There is a lamp in front of Scheehle's house, and he decided to trim this one first. He and his wife were in high glee over his securing the position, and he suggested that he bring the two little ones to see him trim his first lamp. Scheehle loosened the guy rope, and let the lamp down into the street, and stepping to it, seized one of the carbon holders in each hand. In his haste and excitement he forgot to turn off the switch. By an accident the city light wire had crossed one of the Wheeling Electrical Company's wires. Scheehle was standing on the street car track, and the instant he seized the carbon holders a sheet of blue flame encircled his body. Sparks flew in a shower from his hands and feet, and the street railway tracks crackled as the current burned into his shoes. Slowly a thin film of blue smoke arose from his burning flesh, as the current cut deeper and deeper into his now lifeless body. Mrs. Scheehle was rendered speechless by the horror of the scene, but William Juergens, who was passing, dragged the unfortunate man from his grasp on the lamp, but he was already dead. Juergens was considerably shocked, but was not seriously injured. About the time of this accident, John Beltze, another new trimmer, got a current through his body, and was knocked senseless. His injuries are not of a serious character, though he surely would have been killed had not his weight in falling loosened his grip on the lamp fixtures.

Prof. Wurtz on Cyanide of Potassium as a Solvent of Gold.—A correspondent writes:—"The strongest argument in favour of the validity of the MacArthur process, was that one after the other the scientists who gave their evidence for the owners of the cyanide of potassium patents, declared that nowhere was there any mention in books of gold dissolved from its ores by means of cyanide. I have, however, just found that such a solution is mentioned in a book published about 30 years ago. Prof. H. Wurtz patented, in 1864, his process for the extraction of gold by means of amalgam of sodium or potassium. Prof. W. Crookes, in 1865, patented a process for the same object. Prof. H. Wurtz did not like this, and complained in a letter which appeared in Vol. 41, page 216, of the *American Journal of Science*, and in the description of the many advantages of his process is the following passage, which is very remarkable: "When gold has been obtained in solution, *either from ores* or from other materials by the action of chlorine, aqua regia, *cyanide of potassium*, or any other solvent, the most rapid and thorough method of saving these metals will be, &c." Prof. W. Crookes had evidently forgotten the quarrel, the Wurtz letter, and the precipitation of a gold cyanide solution by means of amalgam of sodium, or in giving his evidence he would have mentioned Wurtz. He could not, as a matter of fact, have been unaware of this letter, as when Wurtz filed his specification in this country, Prof. Crookes opposed it, and published in the *Chemical News* the very letter in which Wurtz speaks of cyanide of potassium as a solvent of gold. Evidently, before Wurtz's time, the properties of cyanide of potassium as a solvent of gold in its ores were known, but its use was considered as dangerous, and besides, its price was prohibitive."

Electric Car Accident in the States.—At Cleveland (Ohio) on 16th inst., an electric motor car, conveying between 20 and 30 persons, plunged over a drawbridge in the central part of a viaduct, and fell into the Cuyahoga river, 100 feet below. The viaduct is 3,000 feet long, and when the car was approaching the middle, where the drawbridge is situated, the conductor went forward to release the switch, and although the gates across the road were closed, he signalled the way clear. The motor man accordingly applied the current, and the car crashed through the gates and fell into the water. Those who did not jump from the car were drowned.

Small Arc Lamps.—The New York *Electrical World* "Digest" contains a reference to data given in the *Elek. Anz.*, October 3rd, regarding small arc lamps introduced during the year by a German firm. With a current of 1 ampère at 32 volts, a candle-power of about 70 is obtained (whether this is the maximum or the mean spherical, is not stated, but presumably it is the former); the regulation is said to be very close. For such low-current lamps, as those for 1 to 3 ampères, the contact feeding mechanism is claimed to be far preferable to clockwork, provided that the mechanism which feeds the carbon is constructed properly with respect to the magnet windings and the arrangement of the contact; in clockwork mechanism the feeding is done by the weight of the carbon holders, but in a contact lamp the carbons are forced together. An important difficulty encountered in small lamps is, that the small carbons cannot readily be kept in line; in the present lamp there are guides a short distance above and below the arc which keep the carbons in line. In one installation 40 incandescent lamps, taking 20 ampères and giving 640 candles, were replaced with five pairs of arc lamps taking 2 ampères each, making a total of 10 ampères, and giving a total light of 1,500 candles; with more than double the light, therefore, the current was halved, which represents a saving for the current of about 15 cts. per hour; the increased first cost of the arc lamps over the incandescent, therefore, is not appreciable in comparison, and the cost of the carbons is partly balanced by the cost of the renewals of the incandescent lamps. A modified system of connecting three lamps is shown, and consists in having two in multiple arc, and the third in series with these two; by that method three lamps of different candle-powers may be used. The *Electrical World*, in an editorial note, recommends the use of small arc lamps to the attention of American electrical engineers, and thinks the matter may be worth investigating. The lamps referred to would, thinks our contemporary, be suitable for interior illumination only, and therefore a difficulty at once presents itself in the fact that the use of globes necessary to diffuse the light would nullify the superior efficiency claimed, it having been found that globes used with ordinary arcs for this purpose absorb from 40 to 60 per cent. of the light of the bare arc. There are, however, places where such arcs could be used with clear glass globes absorbing only about 10 per cent. of the light, as in warehouses or in storerooms where a perfectly clear light is desirable, but for which purpose the ordinary arc would have too great an intensity.

The Ansell Dinner.—As we briefly recorded in our last issue, a dinner was given last Thursday evening at the Holborn Restaurant, to celebrate the 50 years' work of Mr. W. T. Ansell in the Telegraph Service. It was an important event in the history of telegraphy, and the gathering was in every way representative of the telegraph interests. There were present Mr. W. H. Preece, C.B., F.R.S., Sir Henry Mance, Prof. Hughes, F.R.S., Mr. C. E. Spagnoletti, Mr. J. Gavey, Mr. C. Gerhardi, the Hon. A. G. Brodrick, Mr. J. Denison Pender, who presided, Mr. R. M. Cunningham, Mr. A. Le Neve Foster, and many others. The meeting signified the estimation in which Mr. Ansell is held in this country, while the numerous foreign telegrams testified to the veneration in which he is held all over the world. The speeches were full of good feeling, and when Mr. Ansell's health was proposed, the toast was greeted with immense applause, musical honours being accorded to the guest of the evening. Mr. Ansell's reply was simple, but admirable; it struck the right note all through, and when the speaker resumed his seat, he must have felt that the enthusiasm was very real. During the evening Mr. Ansell was presented with a gold watch, and a diamond brooch for Mrs. Ansell, as a token of the event. We offer our felicitations to Mr. Ansell on his rare achievement, and trust that he may be long spared to continue his useful work.

High Voltage Lamps.—Mr. Sydney W. Baynes has sent us a copy of a letter, addressed to a contemporary, complaining of a notice of the high voltage lamp manufactured by Messrs. G. Straus & Co. A letter therein referred to (presumably from Mr. Baynes) was forwarded on behalf of the first consignment of lamps he received, and not for the pattern illustrated in the notice. This letter has apparently now been incorporated in Messrs. G. Straus & Co.'s catalogue, together with a clerical or printer's error, without the knowledge or consent of Mr. Baynes, and as the original design and quality of lamp have not been adhered to, he complains.

The Necessity for Standardising Lamp Sockets.—Writing to the New York *Electrical Engineer*, a correspondent (Mr. Alfred Swan) says:—

> The letters you have so far received each indicate a preference for one or other of the present types of socket—one writer preferring this type, the other that—but none give *reasons* for their preference. Would it not be well, therefore, at this stage, to have an interchange of views as to what each writer considers are the points of recommendation peculiar to the type he prefers—thus the question will be, how may those good points be embodied in one and the same socket? In my former communication I said of the Thomson-Houston base that it favoured a "simpler, safer and less expensive" form of socket. I now desire to substantiate that statement by reasons. It is *simpler* because of its fewer parts, and because no insulation is needed to guard against a short circuit through the metal forming its outer case. It is *safer, electrically*, because, in handling, there is little or no risk of an accidental contact between an electrode and the case of the socket (both electrodes being internally situated within the circumference of the porcelain block to which they are affixed), while, in regard to the other types, it is this liability to accidental contact which makes them faulty in this respect. It is *safer, mechanically*, than the screw-shell of the Edison type, because the latter, having a very coarsely pitched thread, is liable to work loose by vibration, whereas the contact nipple in the centre of the Thomson-Houston socket is *finely threaded*, and therefore much safer in this respect. It is *less expensive*, because of its fewer and simpler parts, and also by reason of the arrangement of its electrodes, it admits of reduced proportions in every respect. It is objected that this form of socket involves a more expensive *base*. But this question, I apprehend, is not to be determined by types *as at present embodied in practical manufacture*, but rather by the *possibilities inherent in each case*—and, viewed from this standpoint, there does not appear to be, and really *is* not, any valid reason why a base adapted to a Thomson-Houston type of socket *should* cost as much as it now does, or indeed, any more than for the other types.

Approximate Formulæ for American Wire Gauge.—The following approximate formulæ for resistance, weight, and area of wires, based on the American or Brown and Sharpe wire gauge, are stated in the New York *Electrical World* by Cary T. Hutchinson, Ph.d., to have been found very convenient when no table is at hand. Let

R = the resistance per 1,000 feet of wire.
W = the weight per 1,000 feet of wire.
$c.m.$ = the area in circular mils.
N = gauge number (No. 0, $N = o$; No. 00, $N = -1$, &c.).

Then

$$R = 10^{\frac{N-10}{10}}$$

$$W = 10^{\frac{25-N}{10}}$$

$$c.m. = 10^{\frac{50-N}{10}}.$$

Or, calling x the antilogarithm of a in the formula, $x = 10^a$.

$$R = \text{antilog}\,\frac{N-10}{10}$$

$$W = \text{antilog}\,\frac{25-N}{10}$$

$$c.m. = \text{antilog}\,\frac{50-N}{10}.$$

The error in the first two formulæ is within 2 per cent. for all sizes up to No. 20. The third formula is less accurate, the error ranging from 6 per cent. for No. 0000 to 2 per cent. for No. 20. The resistance is for 75° F. The calculation is extremely simple when a slide rule with a logarithmic scale on the back is used; the index on the back is set to the mantissa of the logarithm, found by the formula; the resistance is then shown on the front scale. Care must be paid to characteristics and negative logarithms.

Obituary.—We regret to learn of the death of Mr. Holbrook Cushman, which occurred at his home in New York on October 25th, at the age of 38 years. Mr. Cushman was well known amongst electricians in this country about ten years ago, at which time he was head of the electrical department of Messrs. Mather & Platt. He then returned to America, and became an instructor of the physical department and head of the laboratory at Columbia College, New York. Mr. Cushman was a member of the American Institute of Electrical Engineers.

Mercurous Chloride Electrodes.—From some recent researches by G. W. Coggeshall, it would appear that amongst a number of the ordinary calomel electrodes we must expect from time to time deviations from the constant value. After various experiments the device of placing over the mercury a quantity of sand grains was resorted to, and the saturation of the solution was completely ensured. With cells modified on this plan, Coggeshall found that the E.M.F. during 40 days did not deviate from the normal value by more than 0·0008 volt. It was also experimentally demonstrated that the size of the mercury surface does not affect the constancy of the electrode; that commercial calomel is only very slightly inferior to the pure compound, and that the time required for the E.M.F. to reach its constant value is in most cases from 30 to 48 hours. The constancy of ordinary calomel electrodes may be regarded as within about 0·001—0·002 volt. The E.M.F. increases with the temperature, the coefficient between 0° and 25° C. being 0·000678, and between 25° and 50° C. 0·000647 (volt per degree), whilst the E.M.F. reaches its full value in a few hours after the increase of temperature.

Porous Diaphragms.—Although a porous, earthenware, or porcelain cell is, strictly speaking, a non-conductor of electricity, the expression, "resistance of a diaphragm" is very commonly used to indicate the increase of resistance produced by introducing the diaphragm into a given electrolyte. In the *Electrotechnik und Elektrochemie*, Vol. ii., p. 83, there is a paper by F. Kruger on "The Resistance of Porous Diaphragms in Various Electrolytes." He tabulates a number of values which he has obtained in his investigations, and concludes that this resistance varies with that of the electrolyte, and is probably proportional to the specific resistance of the electrolyte. A definite conclusion will doubtless be arrived at in subsequent experiments.

The Telephone in Bermuda.—Mr. R. A. Ferguson, manager of the Bermuda Telephone Company, writing under date October 22nd, 1895, from Hamilton, Bermuda, says:—"I was very much interested in Mr. A. R. Bennett's paper on "Some Lessons in Telephony," also in your editorial on the same subject. Therein you remark, that, 'after all, Norway, with one telephone to 144 inhabitants, must take second place to New Zealand with one in 120.' It may be interesting for you to know that here, in Bermuda, we have one telephone to 65 inhabitants. The population of Bermuda is 15,000—9,000 of which are coloured, and we have less than six telephones amongst them—so that really our telephones are held by the 6,000 whites. Our rates are: Business telephone, £8; private residence, £6; no toll is charged on trunk lines, but we have a charge for running the wires outside a one-mile limit of each central exchange, of which there are three."

Cardiff Electric Lighting.—At one of the last meetings of the Lighting Committee, it was resolved unaminously:—"That this committee desire to place on record their appreciation of the valuable and important services rendered to Cardiff by Mr. W. H. Massey, as consulting engineer, and also to convey to Mr. Massey their sincere thanks for the conspicuous ability displayed by him in the carrying out of the work, and of the many intricate details in connection therewith." And this in spite of Mr. Sydney F. Walker!

Rumoured Peerage for Sir John Pender.—The London correspondent of the *Manchester Courier* is responsible for the statement that Sir John Pender will be among those to be promoted to the peerage among the New Year honours.

NEW COMPANY REGISTERED.

Tramways Construction Company, Limited (45,978).—This company was registered on November 14th with a capital of £100,000, in £10 shares, to construct, equip, repair, and maintain under contract, or as owners, tramways and other ways, to be used for traction by electricity, steam, or other agency. The subscribers are: H. R. Beeton, 6a, Austin Friars, E.C., stockbroker, 300 shares; J. B. Concanon, 28, Austin Friars, E.C., stockbroker, 500 shares; W. Haldenstein, 35, Hyde Park Gate, S.W., tanner, 100 shares; H. W. Jefferson, 75, Old Broad Street, E.C., gentleman, 500 shares; H. Oppenheim, 14, Austin Friars, E.C., 500 shares; J. Morris, 17, Throgmorton Avenue, E.C., solicitor, 500 shares; H. Marnham, 31, Throgmorton Street, E.C, stockjobber, 500 shares. The number of directors is not to be less than three, nor more than seven. The subscribers are to appoint the first; qualification, £250; remuneration, £200 each per annum. Registered office, St. Michael's House, Cornhill, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Milver Portable Electric Battery Syndicate, Limited (44,003).—This company's statutory return was filed on September 23rd; 3,980 shares have been taken up out of a capital of £20,000, in £5 shares, and 3,020 are considered as paid; £4 per share has been called on 960 shares, and £2,659 has been paid, leaving £1,181 still to be paid in.

Immisch Electric Launch Company, Limited (41,118).—This company's annual return was filed on October 17th. The capital is £12,000, in £1 shares (2,000 preference); 8,965 ordinary and 1,647 preference have been taken up, and the ordinary have been issued as paid; 10s. per share has been called on the preference, and £623 has been paid, leaving £200 10s. still to be paid in.

Manchester Suburban Electric Supply Company Limited (43,884).—This company's statutory return was filed on September 13th. The capital is £25,000 in £1 shares, and seven shares have been taken up, but nothing has been called.

Automatic Electric Sign Company, Limited (44,685).—The registered office of this company was, on October 26th, removed from 10, Tanfield Chambers, Bradford, to 9, Swaine Street, Bradford.

Maudslay, Son & Field, Limited (28,681).—This company's annual return was filed on October 18th. The capital of £350,000 in £10 shares (10,000 preference) has been taken up, 25,000 shares have been issued as paid, and the full amount has been paid on the remainder.

D. Hulett & Co., Limited (29,463).—This company's annual return was filed on October 14th. The capital is £35,000, in £5 shares (100 founders'). 5,900 ordinary and 100 founders' shares have been taken up, and 4,100 are considered as paid. £9,500 has been paid on the rest.

Roger Dawson, Limited (37,901).—This company's annual return was filed on October 24th. The capital of £15,000 in £1 shares has all been taken up, and 14,993 shares have been issued as paid; £7 has been paid on the rest.

CITY NOTES.

Electro-Chemical Company, Limited.

The second ordinary general meeting of this company was held at the company's registered offices, at St. Helen's, on Tuesday, November 5th, 1895. Colonel T. J. Holland, C.B. (chairman of the company), presided.

The Secretary and General Manager (Mr. J. Leith) having read the notice convening the meeting,

The Chairman said: Since I addressed the shareholders of this company at our statutory general meeting in London last year, our registered office has been removed from Middlesex to Lancashire, from London to the company's works at St. Helen's, and having therefore no further official connection with London, we hold this meeting here at the works, to enable shareholders to satisfy themselves as to the progress made in our manufacturing operations. This location of the company's registered office in Lancashire may, perhaps, be somewhat inconvenient to your directors personally, as well as to other shareholders residing in London and the South of England, but it is manifestly one in the best interests of the company at large, and will doubtless be more convenient to several shareholders living in Lancashire, Yorkshire, and the North of England generally, in which district our principal business will be transacted. We have, as stated in the report, been much occupied during the past year in making the necessary arrangements to enable us to commence manufacturing operations as soon as practicable, with a due regard to future commercial success. The first and most important matters to consider in starting any new manufacturing business are, and must always be, the selection of the best and most appropriate site for its works, and the best and most efficient plant and machinery available for its purposes; in fact, on these two points alone depends, I believe, to a very great extent, the future success or failure of commercial working. The essential difficulties in these days, owing to keen competition, of making any manufacturing business pay, or of carrying on any manufacturing business profitably, are so great in themselves, that it would be absolute folly to add to these difficulties, and to handicap new works for ever in the future by rushing matters at the beginning simply to make an early start, and thus probably sacrifice to that one object alone, all prospective commercial success, by placing such works in an unsuitable locality, or by fitting them with unsuitable plant and machinery. Acting on

this principle, we have been very careful in selecting the best and most desirable site for our works, very cautious in choosing and ordering the best and most reliable plant and machinery for our manufacturing purposes. Some may think we have been too careful, too cautious, and that valuable time has been wasted over ordinary matters of no very great importance; all I can say is that I do not agree with those who hold such opinions. In our own case, for instance, I may say that if we had hurried matters, and, with the object of making an early start, had selected even the very best of the many sites first offered us for our works, or had hurriedly ordered in plant and machinery, without very careful thought and consideration, we certainly might have gained some credit for starting a few months earlier, but, on the other hand, we should not have been able to look forward with anything like the confidence we now do to the future success of our operations. I will explain why this is so:—If the site selected for alkali works such as ours were at any appreciable distance from coal fields, and salt and lime works, the general cost of the principal mineral and the principal chemicals we use for manufacturing alkali by our process, would be vastly increased, for the charges of conveying coal, salt and lime from their sources of supply to manufacturing works at any great distance, would double or even treble their original cost, and such increased charge would eat up a good share of the profits of actual manufacture. Then if the site selected for alkali works were at any considerable distance from the works of alkali consumers or users, a large slice of the manufacturing profits, instead of going into the pockets of the shareholders of the manufacturing company, as they should do, would be spent in heavy and continuous railway and other charges to convey the manufactured alkali to its destination; then again, if the site selected were far from railway or canal, the charges for carting coal, salt, lime, and other supplies from railway or canal to manufacturing works at any great distance, together with the charges for carting the manufactured alkali from the works to railway or canal would be enormous, and would reduce manufacturing profits proportionately, and when it is remembered that we shall require for our manufacturing operations some 1,600 million gallons of water annually, or say, over 5,000,000 gallons every day, the selection of a site where a very large, continuous and inexhaustible supply of good and pure water, at a minimum cost, from more than one source is obtainable, must be a matter of vital importance for such works as ours. Again, if the site selected for new alkali works were too near farm or agricultural land, too near pastures, gardens, or growing crops, on all of which chlorine gas is said to have a deadly effect, though, by our process, no chlorine gas is allowed to escape, still an injunction might be applied for even against our manufacturing operations, resulting, at all events, in heavy legal expenses, and possibly, in these days of severe agricultural depression, in the summary closing or stoppage of our works, and the absolute waste of nearly all the money spent on buildings, plant and machinery. All these and other matters had to be very carefully considered in selecting a site for our works. Your directors, however, fortunately for the interests of this company, are all of them practical business men, intimately connected with and experienced in carrying on large manufacturing works, of which they themselves, in some cases, are the principal proprietors, and all of them being large users of the alkali we make here; they all know most of the requirements for such work as ours; they have all given up a great deal of time, care and attention in selecting the best and most appropriate site available for our works, and in choosing and ordering the best and most efficient modern plant and machinery. I, myself, accompanied by our experienced general manager, have well nigh scoured, in search of a good site, the north of Wales, and the counties of Cheshire, Lancashire, Durham and Staffordshire, all districts in which comparatively cheap coal, salt, or lime are obtainable, and I feel very sure that by far the best premises available have been selected here at St. Helen's, and have, moreover, been obtained on most advantageous terms for this company, at something like a quarter of their original cost, though we may have had to wait some little time to secure them; for in addition to obtaining, as we have several good large substantial buildings, excellent business offices, a good and commodious manager's residence, a few workmen's cottages, large paved yards, a good substantial chimney stack, connected by large brick-built flues to all parts of the works, an excellent siding on the London and North-Western Railway, a good wharf on the St. Helen's and Mersey canal, and several other advantages, all of which will be most valuable to us hereafter in our manufacturing and commercial operations. We have here every one of the requirements I have named as necessary or advisable for such works as ours; for instance, as far as coal is concerned, our works are close to a good, large, and productive colliery, and they are literally surrounded on every side by other collieries, from two of which we are now buying excellent coal well suited for our purposes at 4s. a ton delivered at our works, and from a third of which collieries we now have a tender before us to supply us with coal over 1896 at 3s. 6d. a ton. I doubt if such coal could be obtained at lower prices anywhere else. Then we are also comparatively near both salt and lime, for the conveyance of which to our works we pay respectively only 2s. and 2s. 9d. a ton, and St. Helen's occupies, I believe, the most central position to be found for the conveyance of alkali, our manufactured bleach and caustic soda to the works of the principal consumers of these chemicals, the bleachers, the papermakers, the soap makers of Great Britain and Ireland. We have also here excellent facilities for the conveyance of our alkali by canal to Liverpool for transport, thence by water to all the ports of Great Britain and Ireland, as well as by ocean or sea to North and South America and other countries. Railway and canal rates from St. Helen's are, moreover, I believe, as low as, or lower than, from any other place in the kingdom; as to distance from railway or canal, our works are right on the London and North-Western Railway, the largest and the best carriers, I believe, of minerals and chemicals in the world; we have, as I have said, an excellent siding on that line, connected with rails all round our buildings. We are also close to the Manchester, Sheffield and Lincolnshire Railway, on which line we shall probably be able to obtain a siding if we require it, and we have, as I have stated, our own wharf on the St. Helen's and Mersey Canal, also connected by rails to every part of our works. We have, therefore, nothing to pay for cartage to or from railway or canal. As far as water is concerned, we have an abundant and plentiful supply of good and pure water from the borough waterworks here, as well as from large stores of water lying in the worked out collieries about 100 feet under our premises, and for condensing purposes from the St. Helen's and Mersey Canal which flows along one side of our works, and as to general situation our works are in a large chemical and not in an agricultural district, they are in a district where alkali and chemicals generally have, I believe, been manufactured for the past century; we have, therefore, no fear of being pulled up for injuring our neighbours by our alkali manufacture. Under all these circumstances, I think even the most impatient of our shareholders must admit that we did well, and acted wisely, in waiting till we could secure such premises as these. The same care and forethought that were exercised in selecting a good and suitable site for our works, were also given to obtaining the best and most efficient plant and machinery for our manufacturing purposes; here again we visited the works of several engineering and other firms, and having satisfied ourselves as to the best, the most efficient modern electrical generating plant required for our purposes, careful specifications were prepared by our eminent consulting electrical engineer, Mr. James Swinburne, tenders were invited from some of the principal manufacturing engineers in the country; such tenders as Mr. Swinburne recommended were accepted, and contracts were made with the parties concerned accordingly. Then buildings were adapted to suit the requirements of engines, dynamos, boilers, economisers, electrolytic tanks, and electrical generating plant generally, large water mains were laid for our condensing water to the St. Helen's and Mersey Canal, with the consent and approval of the canal and the borough authorities, and bleach chambers, caustic pots, furnaces, and other alkali appliances were all put in hand. An exceptionally severe winter, with long sharp frosts and deep snow, prevented our progress quite as rapidly as we might have wished, and the unforeseen, the extraordinary, and the apparently unaccountable dilatoriness of the manufacturing engineers (whose weeks seem each to have numbered about 30 days) in delivering their engines and dynamos, caused further delay, when all else was ready. However, all earthly things must, I suppose, come to an end some time, even engineers' lengthy weeks, and all these delays now being over, we are happily at work at last, having made a good start on a good site with good plant, and, I trust, good and efficient machinery, all of which I am sure you will be pleased to learn has been purchased and erected at figures lower, instead of higher as usual in such cases, than the original estimates, and we have proved, and are daily practically demonstrating to the sceptical chemical world, to the expectant electrical profession, that purer and better bleach and caustic soda can be made by our simple electrolytic process, than by any of the older processes, and can moreover be so manufactured at something like 50 per cent. less cost. Now, gentlemen, I know I am addressing a body of shrewd, practical business men; one expects to meet such at a business meeting of this sort, especially in such a county as Lancashire. I am aware, too, that some of those present listening to me are interested in, and understand the details of alkali manufacture by the older processes, and that others present also attending to my words are electricians, engineers and chemists, and are thoroughly conversant with matters connected with electrical engineering, chemistry, and electro-chemistry, and I know also that all present have to-day themselves personally carefully examined, and critically inspected our premises here, their surroundings, their situation generally, their buildings, plant, and machinery; yet notwithstanding all this information before me, and it is enough to make me very careful as to what I say, I have no hesitation in stating, even before such an audience, without fear of contradiction, for I know every practical man who understand the sort of work we have been engaged in, will agree with me that we, your directors, or Mr. Leith, your general manager, could not, under all the circumstances, have pressed matters forward more rapidly than has been done, with a due regard to the future success of our operations, and I am confident, too, that all who have had any practical experience in starting large new manufacturing works, will also agree with me when I say that, considering the size, the magnitude of these works, and the many most important details, some of them quite of a novel nature, requiring very careful consideration and attention, it is really a matter of sincere congratulation for us all that we have been able to start, and make a good start, too, as soon as has been done. In regard to the sale or working of our valuable foreign and colonial patents, we felt that until we could show our works in active operation in our own country, little or no advantage could be gained by pressing the sale or working of those patents in other countries; we have therefore, up to the present, contented ourselves with keeping up or maintaining these foreign and colonial patents according to the patent laws of their respective countries; but foreseeing how very valuable such patents must become, if the process continues to work as satisfactorily as it has begun to do here, and if it proves as profitable as we hope and believe it will do, we have applied for additional patents in India, Russia, Spain, Sweden, Norway, Denmark, Portugal, Turkey, Mexico, Argentina, Chili, Brazil, Uruguay, New South Wales, Queensland, South Australia, Western Australia, Victoria, New Zealand, Tasmania, the Cape of Good Hope, Natal, and the Transvaal. All these patents, together with the foreign and colonial patents originally acquired by this company on its formation, we hope to dispose of in due course at very remunerative prices. Our Russian patent rights, as stated in the report, have already been sold, subject to a short test of the working of the process here at St. Helen's, which test will

probably take place this month; the contract for the sale and purchase of these patent rights was signed some months ago. As, however, the whole amount of caustic soda and bleach used in all Russia is very small, not more, I believe, than 3 per cent. of the quantity used in the United Kingdom alone, and as it is a most difficult matter for any English company or English firm to work Russian patents profitably in Russia, we could not expect to realise a very large sum by the sale of these patent rights; we therefore thought it desirable to accept at once the *bonâ fide* offer we received for them from a solvent and reliable party, and have sold them for £6,000. We hope, however, to realise considerably higher prices for some of our other foreign patents. Our process has been at work for some time in a paper mill in France, where the plant and machinery for it were erected by our men, under the supervision of our general manager. The working there has, I believe, given every satisfaction, the papermaker using it having expressed himself very pleased with it. The practical results of the working in France, like the practical results so far of the working here at St. Helen's, have proved even better than those obtained during the two years the process was worked at Snodland, in the county of Kent, prior to the formation of this company. You will gather from what I have said, that without in any way pressing the sale or working of our foreign patents, some progress has already been made in that direction, and I may add that considerable interest has also been shown in our process and patents by papermakers and others in other countries, especially in Austria-Hungary, Belgium, Spain, Mexico, Canada and Italy, with all of which countries we have lately been in negotiations for the sale of our patents there. I hope our plant and machinery will shortly be erected in a paper mill in Italy, with the object of selling our Italian patents, and now that we have something practical to show in this country, I trust we shall go well ahead with the sale or working of all these foreign and colonial patents. We have refrained, up to the present, from issuing licenses to papermakers and others to work our process in their paper mills or factories in the United Kingdom according to the contracts or agreements with them taken over by this company; we have advisedly refrained from issuing these licenses until our own works were completed, and until we could clearly ascertain the best, the most economical, and the most compact form in which the plant and machinery required should be constructed to fit into the limited space available in the works of alkali users. Though these contracts for the issue of licenses entered into by the vendor company, and taken over by this company on its formation, must, I suppose, be fulfilled some day, and though these licenses on the agreed royalties must, I conclude, be granted eventually, if pressed for within a reasonable time by the parties concerned, I candidly confess I personally am not in favour of encouraging this class of business for this company, for though the issue of these licenses might, and doubtless would have been a very beneficial arrangement for the vendor company, with its small works in the South of England, where it had to contend with high prices for coal, salt, and lime, and heavy charges for the conveyance of its manufactured alkali, the issue of such licenses by the Electro-Chemical Company to alkali users to work the process independently in their own mills or factories, would not be anything like so beneficial an arrangement for us here, where we hope, when our full works are in operation, to be able to make a profit of something like £3 or £4 on every ton manufactured, whereas by the issue of these licenses we should not be able to get a quarter of that amount; therefore, in the interests of the shareholders in this company, with its ample facilities for extending its manufacture on the best and most profitable terms, I believe the wisest course will be for us to manufacture, as far as possible, all our electrolytic alkali ourselves here, to meet the requirements of the British, the Irish, and, perhaps, the American markets, and to issue no more licenses than we are obliged to do. I have been asked to say a few words on the Castner electrolytic process recently advertised. It seems, however, hardly necessary for me to do so here, for, as far as I can see, that process does not affect or touch us in any way whatever. Their patents were taken out some two or three years after ours, and therefore they cannot take advantage of any part of our inventions. We use iron cathodes which last a long time, and cost 1s. 8d. each, or about £1,000 for all our 800 large electrolytic tanks, capable of producing 20,000 to 30,000 tons of 70 per cent. caustic soda and bleach annually. They use mercury cathodes, which will cost them, at a very low calculation, £7 each, and this for a plant with the same number of cathodes as we shall have, and the same sized plant as ours, means over £80,000 for mercury alone; mercury is a liquid metal readily volatilised, and, as we know from our barometers and thermometers, is highly sensitive to atmospheric, climatic, and thermotic influences, and its evaporation is very dangerous to human, animal, and vegetable life. They use heavy oscillating electrolytic tanks, far more costly and less durable than our fixed stationary tanks, and requiring machinery, belting, and power to drive, none of which are needed by our process; and their spindles, oscillating machinery, and bearings, are liable to get corroded and eaten away as soon as an escape of chlorine gas touches them, and they are surrounded on all sides by chlorine gas, day and night. In fact, theirs is a complicated, elaborate, costly system, working in the midst of the deadly volatilising fumes of mercury, which costs them at least 2s. a pound to produce caustic soda and bleach, the top sale price of which is ¾d. a pound. We use no re-agent or oscillating machinery, no belting, driving gear, or bearings whatever, and our process is as simple as A, B, C, and works in a perfectly pure and healthy atmosphere. The success of our process has been thoroughly established by practical working on a large commercial scale; their's is hardly yet out of the laboratory or experimental stage. They may make caustic soda and bleach cheaper than is done by the old Le Blanc process, I daresay they will, but they cannot come near us by at least some £20,000 a year, spent on mercury and extra machinery. How, then, can the Castner process affect us in any way? I have now merely to add that our efforts on behalf of this company shall be energetically continued, and will be amply rewarded if the good, profitable, and successful results we anticipate from our future commercial operations are fully realised. I beg to propose that the report and balance-sheet submitted to you be received and adopted.

Mr. John Henry Walter seconded the resolution.

Mr. R. Taylor hoped that future general meetings might be held in London, and not all at St. Helen's; he considered that though St. Helen's probably was the best place for their works and their manufacturing operations, it was certainly not a desirable or beautiful locality for shareholders to come to, and now that they had had the opportunity of seeing how thoroughly well and efficiently all the arrangements had been carried out, and what excellent premises they had, he trusted future meetings might be held in London. He considered that Japan was a rising country, and one in which the company ought to have a patent, and he would like to know if it was probable that any more shares would be issued; if so, he hoped the shareholders would be allowed to take them up themselves, as no doubt they would be very pleased to do. There was, in his opinion, no necessity for offering new shares (if ever issued) outside the company, when the shareholders themselves would be only too glad to take them.

The Chairman, in reply, said that he, personally, also hoped future meetings would be held in London, but the company's interests must be the first consideration; the directors would, however, carefully consider the question raised. In regard to Japan, the Japanese patent law was rather peculiar, as none but the Japanese themselves were allowed to take out patents in Japan, and all foreigners were absolutely shut out from taking such patents; at the same time, he might state that a Japanese papermaker, in a good position in his own country, had already been over to England about the electro-chemical process, and wished to take a patent out in Japan for it. They were now in negotiation with him for the purpose, and he had agreed to pay for information to enable them to do so, and also for the authority of the owners of the British patents to make use of their invention in Japan. He (the chairman) believed that this company would derive considerable pecuniary benefit by the arrangement proposed. In regard to the issue of the remaining shares, these possibly might, or might not, be required, as the large sums that ought to be received before long by the sale of some of the foreign patents he had referred to would (if not received in instalments) be sufficient to carry out any probable extensions in the works at St. Helen's, without issuing any more shares.

Mr. C. Tylden Wright said that the site selected, the buildings, plant and machinery, appeared all that could be desired for large chemical works, and, as a chemist himself, he was of opinion that nothing could have been better planned or arranged.

A Shareholder asked if the general manager was able to realise as high prices for their caustic soda and bleach as the United Alkali Company obtained.

The Chairman replied that they had never sold anything yet under the top prices fixed by the United Alkali Company; they found no difficulty in realising these prices, or in selling their products, on account of the purity of their bleach, and caustic soda, which, evidently by the repeated orders they received, met with the approval of consumers; they had already sold about all they could make in 1896 unless the plant were enlarged.

The resolution for the adoption of the report and balance-sheet was then submitted and carried unanimously.

Messrs. T. M. Dunster and Lewis Evans were re-elected directors, and Messrs. Gane, Jackson, and Jeffries were re-elected auditors.

A vote of thanks was given to Mr. Leith, the general manager, and to all those who had worked under him during the year.

A vote of thanks to the chairman and directors terminated the proceedings.

City of London Electric Lighting Company, Limited.—We understand from the *Financial Times* that a meeting was held on Monday afternoon at Winchester House, but their representative was informed that the proceedings were private.

The Eastern and South African Telegraph Company, Limited.—This company announces the numbers of 5 per cent. mortgage debentures drawn for payment at par on January 1st, 1896.

British Electric Traction (Pioneer) Company.—The allotment letters for the recent issue of 5,000 shares have been posted. The applications were largely in excess of the capital required.

TRAFFIC RECEIPTS.

The Bristol Tramways Company. The receipts for the past week show an increase of £458.

The City and South London Railway Company. The receipts for the week ending November 17th, 1895, **amounted to** £958 (partly closed on Sunday for alterations at King William Street station); **week ending** November 18th, 1894, £972; decrease, £14; total receipts for **half-year, 1895,** £17,616; corresponding period, 1894, £17,691; decrease, £75.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending November 17th, 1895, amounted to £1,028; corresponding week last year, £881; increase, £147.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 15th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,243.

The West India and Panama Telegraph Company. The receipts for the fortnight ended November 15th were £2,120, against £1,994.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. †	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Nov. 13th.	Closing Quotation Nov. 20th.	Business done during week ended Nov. 20th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	101 —105	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	43 — 45	43 — 45	44	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	82½— 83½	82½— 83½	83½	82¾
2,993,560£	Do. do. Defd.	Stock	...	...	...	6½— 6¾	6 — 6½	6⅝	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13½— 13¾	13 — 13½	13¼	13
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	164 —168	164 —168	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½— 21½	20½— 21½	21 5/16	21
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107	104 —107	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	8¼— 8¾	8¼— 8¾	8 7/16	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16½— 17	16 — 16½	16⅝	16½
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17¾— 18½	17½— 18	18	17 5/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —129	125 —128	130	126
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17½— 18	17½— 17¾	18	17½
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	106	103
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	126 —129	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —107	103 —107	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	104 —107	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	9½— 10	9½— 10	9⅝	9½
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16 — 17	16 — 17	16⅝	16½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21¾— 22¼	21½— 22	22⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	104½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	47 — 50	46 — 49	49½	48½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2½	2 — 2¼xd	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅞— 6⅛	6 — 6¼	6⅛	5 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15½— 16½	15½— 16½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼— 6½	6¼— 6⅝	6 7/16	6⅜
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107	105 —107	107	106
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	109 —112	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	5½— 6½xd	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	129½	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2¾— 3¼	2¾— 3¼	2 9/16	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	100 —105	98 —103	101¾	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	9¾— 10½	9¾— 10½	10	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 6¾	6¼	6¼
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	3¼— 3⅜	3¼— 3⅜	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	¼— 1⅛	⅜— 1	1/16	¾
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10¼— 10⅜	10 — 10½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8¼— 9⅛	8¼— 9¼	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	2½%	5 %	5 %	6¾— 7½	6¾— 7½	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 — 119	116—119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	12½— 13½	12½— 13½	13	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 16⅝	15⅝— 16¼	16⅝	16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —135	131 —135	134	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9½	8½— 9½	...	..
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8⅞— 9¼	8⅞— 9¼	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅛— 8⅛	7⅛— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10 — 11	10½— 11½xd	11	10
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9½	8½— 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8⅝	8 — 8⅝	8¼	8 3/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9½	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8 — 8½	8 — 8¼	8 7/16	8

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked † are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Nov. 13th.	Closing Quotation, Nov. 20th.	Business done during week ended Nov. 20th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	1½— 1⅝	1½— 1⅝	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	1⅞— 2⅛	1⅞— 2⅛	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000*l*	City and South London Railway	Stock	8%	8%	1¼%	40 — 42	40 — 42	40¼	40
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1½ — 2½	1½ — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1⅝ — 2¼	1⅝ — 2¼	2	...
17,139	Do. do. do. "A" Shares 01—017,139	5	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	¾— 1	⅝— ⅞	1⅛	⅝
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2¼xd	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— ⅝	⅜— ⅝	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	¾ — 1	½— ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	14 — 14½	14 — 14½	14¼	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½ — 16¼xd	15½ — 16½	16½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	..	...	...	108 —111	108 —111	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 20	18½ — 19½	19	18¾
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅜ — 11⅞	11⅜ — 11⅝	11⅝	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15½— 15⅝	15½— 15⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	40 — 42	40 — 42	42	40
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅛— 5	4⅛— 5	5⅛	4⅛

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 189

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½% 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 98—102.

House-to-House Company (£5 paid), 4¼—4½.

Do. do. 7 % Preference, of £5, 8—8¼.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7⅞—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8¼

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅞—7¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

MUNICIPAL TELEPHONY.*

By A. R. BENNETT.

(*Concluded from page* 623.)

Having told you the terms on which the telephone is supplied in Trondhjem, I shall now proceed to let you know what the subscribers obtain for their money. The subscribers are connected to the exchange chiefly by single aerial wires of phosphor-bronze, but some have copper wire carried in suspended cables. Communication is obtainable at present only between the hours of 8 a.m. and 10 p.m., Sundays included; but the early establishment of an all-night service is contemplated. There are 11 towns in the neighbourhood of Trondhjem where exchanges exist, and with which trunk lines afford communication, These outlying exchanges are owned by local companies, not by the Trondhjem Municipality. The charge for speaking to them is 2d. for five minutes for subscribers, and 3½d. for non-subscribers.

The most distant of these are:—

Hovin	... ...	28½ miles.
Stören	... ...	31 „
Gosbak	... ...	34⅜ „
Svorkmo	... ...	47½ „

It is thus possible to speak for five minutes over a trunk line 47½ miles long for 2d.

The Norwegian Post Office is also constructing, for the use of the Trondhjem subscribers, and has nearly finished, two metallic circuit trunk lines through Levanger (43½ miles) to Stenkjær (68½ miles) in the North, which it is intended to subsequently extend to Namsos (105⅜ miles). These lines are of 3 mm. silicum bronze. The trunk line to Christiana (349½ miles) is also to be commenced in 1896. The map before you will give you an idea of the actual telephonic network in communication with Trondhjem, as well as of the contemplated trunks.

There is not at present any communication between the telephone system and the telegraph office, so that the subscribers are not able to forward telegrams from their own houses; but this defect is also to be remedied very shortly, the Town Council having promised to connect with the telegraph office whenever the Government desire it.

Subscriptions are payable half-yearly in advance. The subscriber is only required to sign an agreement for six months, and can discontinue his line at any time by giving notice of that duration. When the subscriber shifts his office or his house, the cost of the labour of reconnecting him at the new place is charged, but the necessary material is provided free.

The police and fire stations are connected, and special facilities are afforded for the calling of cabs, &c. The fire system of Trondhjem is very complete, there being no less than 28 electric fire alarm stations scattered through the town and suburbs, worked by a central battery at the fire office.

This fire alarm system is managed by the telephone exchange, and the cost of maintaining it is borne by the telephonic budget, so that the telephone subscribers really support not only the telephonic exchange, but also the fire alarm system.

There are ten public telephone stations in convenient localities whence subscribers and non-subscribers can obtain communication with Trondhjem and the towns connected by trunk lines. Six of these public stations are situated in kiosks, primarily intended for the sale of newspapers, placed in the streets. The charge is 1½d. per five minutes for local, and 3½d. for trunk talks. One of these kiosks is shown in fig. 1. The fact that they are public telephone stations is indicated by the two telephones suspended from the dragon mouths on the roof. Why similar conveniences should not be provided at busy points in Manchester and other English towns is a problem which I will leave to the members of this society to solve—if they can.

It has sometimes been said in extenuation of the high charges in force in this country that the low rates on the Continent are possible because the construction work is badly done; that cheap material is used, and no efficient technical supervision provided. I have already had occasion to emphatically disagree with these assertions, as in my book on "The Telephone Systems of the Continent of Europe," I give several instances in which the cheapest rates coincide with the best workmanship and most modern material and apparatus. Trondhjem is another case of this nature. The rates are very low, as we have seen, and yet the workmanship and material is extremely good. The wire used is of phosphor-bronze, 1·25 millimetres in diameter, being the same as generally used by the National Telephone Company in this country. Not only is the wire of the same nature and of the same gauge, but it is procured from the same makers, Messrs. Felten & Guilleaume, of Mulheim-on-the-Rhine. As Trondhjem is about 830 miles north of London, it follows that the freight incurred on the wire is very considerably in excess of that paid in England, so that the low rates in Trondhjem are certainly not attributable to the excessive cheapness of the wire used. This

* Read before the Northern Society of Electrical Engineers, Manchester, November 11th, 1895.

wire is supported principally upon iron structures, most of which are fixed on the house-tops, although some, as will be seen from the figures, are planted in the ground.

Fig. 2 shows the roof of the Telephone Exchange at Trondhjem, with the six iron structures provided to receive the subscribers' lines. Beyond the Exchange are seen many similar structures on the other roofs in the town, and on the hill-side may be discerned many villas and private residences, nearly all of which are in communication with the telephone system.

From photographs of some of the roof fixtures employed, the members of this society will deduce that telephone house-fixtures are not necessarily ugly.

Dampers are attached to the wires for the purpose of preventing the vibration of the wires being communicated to the house. These dampers consist of a piece of split India-rubber tube placed round the wire, and then tightly wrapped with heavy leaden wire or strip, a plan which is found to be very effective.

These photographs will show that the Trondhjem telephone fixtures are of a substantial nature. They are, in fact, made of English angle-iron, 2 inches in the web by 1¼ inch thick. The cost of the iron alone, unpainted, in the larger ones is about £15. The preparation of the roof for fixing, and the labour, increases this cost materially. As English iron is employed, on which freight has to be paid to Trondhjem, these overhouse fixtures cannot be cheaper than those employed in this country.

Heavy iron lattice poles are used a good deal. They are provided with a base plate, and are set in concrete, their cost erected being £22 4s. each.

One of the figures is a perspective view of a route of wooden poles along the Söndre Gade.

Wooden poles are used a good deal in one of the suburbs. Although the poles are of wood the cross-arms are of angle-iron.

The subscribers are supplied with the beautiful instruments manufactured by the Norske Elektriak Bureau of Christiania, a specimen of which is now before you. These cost £2 12s. 2d. each, delivered free in Trondhjem, in lots of not less than 100, exclusive of battery. Such subscribers who desire it are supplied with instruments made by Messrs. L. M. Ericsson & Co., of Stockholm, the price of which is higher, viz., £2 17s. 8d., in lots of 100, delivered in Trondhjem. The Trondhjem instruments, therefore, cost more than those supplied to telephone subscribers in this country, while their workmanship is superior.

The insulators used for supporting the wires are made at Porsgrund, in Norway, and cost 2d. each without the bolt. They are of a double-shed pattern. On some of the more crowded routes the subscribers' wires are led in suspended cables. Two of these cables contain 50 wires each, and are of the Pattinson type, that is to say, the wires are insulated with dessicated cotton saturated in paraffin wax, and protected by a heavy leaden tube. Others contain 25 wires and are insulated with India-rubber protected by lead in the same way. These last cables were supplied by Felten & Guilleaume.

The working staff consists of five linemen, who work from 7 a.m. till 6 p.m., with one hour off for dinner. Their pay is £43 6s. 8d per annum with an extra allowance of £6 13s. 3d. to the oldest man, who acts as foreman. The Town Council insures each man for £111 against death, and also for allowances in case of accident or sickness. The premium paid being 9s. 11½d. for each £55 of wages. Although the pay of these men may appear low, it is extremely doubtful whether that of the telephone linemen in any town of equal size, 30,000 inhabitants, in the United Kingdom averages so much.

The operating staff consists of young ladies, eight of whom, with the superintendent, are on duty at one time. At present their duties average a little less than 9½ hours per week day, but as this is considered too long, three new operators are about to be appointed. Their pay at present varies from £2 4s. 5d. to £2 15s. 5½d. per month, but the scale of wages sanctioned by the Town Council provides for an ultimate increase to £3 6s. 7½d. per month. The pay of the lady superintendent is at present £40 per annum. In addition, there is a staff of reserve operators, consisting of young girls who have learnt the business but who, pending vacancies on the permanent staff, are only called in on emergencies. They receive a small retaining fee and are paid for work actually done at the rate of £2 4s. 5d. per month. As each subscriber asks on the average from eight to nine connections per day, the girls have plenty to do during the busy hours. Each girl has 14 days' holiday per annum on full pay, and is insured against sickness. It will be seen that whatever may be thought of the workmen's wages, the lady operators receive considerably more than their English sisters.

It is certainly a strange comment on the talk we have heard of the greater cost of telephonic work in this country to find that girl operators in Trondhjem are paid better than those of London, Manchester, or Glasgow.

In estimating the cost of working the Trondhjem Exchange it is necessary to explain that the Town Council has no way-leave charges to bear. It uses the townsmen's roofs by agreement, but in every case at present, the proprietor is content with his roof being kept in repair, and exacts no annual payment. Of course it is a serious matter to keep so many roofs in good order, but certainly the Trondhjem Town Council is exceptionally fortunate in escaping money payments in addition.

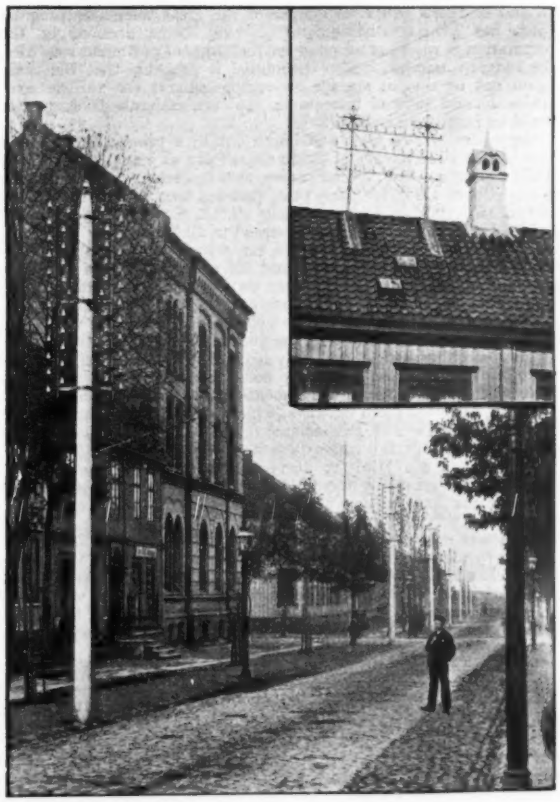
In another respect the Trondhjem Municipality is more fortunate than telephone undertakers in this country—the 10 per cent. royalty payable to Government on exchange telephone subscriptions has no existence in Norway. Not that 10 per cent. added to the Trondhjem tariff would make much difference. The average payment would then be £2 19s. 9d. instead of £2 14s. 4d. Even a 10 per cent. royalty only assumes alarming dimensions when the subscriptions on which it is levied are high.

The switching arrangements at Trondhjem at present consist of eight 100-line boards by Ericsson & Company, Stockholm. There are no special features about them. The ring-off drops are connected in the cords in the usual way. This arrangement is somewhat antiquated and will next year be superseded by a multiple board. A cross-connecting and lightning-guard board is also provided, the lightning-guards being of carbon blocks lying on a carbon plate in connection with the earth, and kept from contact with it by strips of mica. All the work in the exchange has been carried out with excessive neatness, and there is no suggestion of cheapness or neglect about the place.

The second instance of municipal control of telephone systems in Norway is that of Christiania.

In my work on "The Telephone Systems of the Continent of Europe," I give full particulars of the Christiania Telephone Company, which has been a most successful concern. On an inclusive subscription of £4 8s. 11d., it has for many years past paid a dividend of 5½ per cent. per annum on the capital invested after putting aside large reserve funds, writing off values of buildings and system, and providing benevolent funds for its male and female employees. The accounts given in my book for the years 1893 and 1894 bring out these details very clearly.

44-Wire Standard in Kougen's Gade.



Trondhjem Municipal Exchange. Route Along the Soudre Gade, Trondhjem.

At the end of 1894, the company possessed 4,627 exchange lines in Christiania and its immediate suburbs, in addition to being owner of a large system of trunk lines connecting Christiania with the neighbouring towns in every direction. At the end of September, 1895, the number of exchange lines had increased to over 5,000.

The management of the company is invested in four directors, who meet every week, and a managing council consisting of fourteen shareholders, which meets every month. This council is elected by the general body of shareholders, and in its turn elects the four directors. The Town Council, which owns a proportion of the shares, is represented directly on the board of the company by three town councillors, one of whom is a director, and the other two members of the managing council.

The Municipality consequently exerts a great influence on the company's policy, which is to provide the best possible communication at the lowest rates commensurate with the payment of a fair dividend to the shareholders. The Town Council's share of the capital is contributed out of the rates, but as a return of 5½ per cent. is obtained on it, the ratepayers have no cause for discontent.

The outside construction and the particulars of the subscribers' instruments have been fully described in my book, but the original multiple switchboard has just been replaced by one of largely increased capacity and of the most modern type, which switchboard was

brought into use only last month. Although the number of subscribers in Christiania is so great, the rate at which new ones join continues undiminished, and it has therefore been necessary to provide for a very large additional number.

About two years ago, a party in the Norwegian Parliament suggested that the State should take over the whole of the telephone companies, and a committee consisting of the director of the State Telegraph Department, and several other telegraph officials, together with two telephone managers, was appointed to examine the proposal. The committee, which was, of course, an ex-parliamentary one, reported in January, 1894, by a majority in favour of the State acquiring all the telephone exchanges as well as the existing trunk lines. But there was also a minority report which recommended that the State should only acquire the long trunk lines, leaving the local exchanges and the shorter trunk lines, that is to say, those connecting neighbouring towns, in the hands of the private companies and municipalities already working them.

When the report of the Committee was published, the Norwegian telephone companies and municipalities owning telephone systems formed themselves into a Defence Association, and after holding two meetings at Christiania, at which most of the companies and municipalities were represented, an energetic protest against the report of the committee was presented to Parliament. The contention of the Defence Association was that the State was not in a position to meet local requirements so well as local companies or municipalities could do, and so there would be danger of the great telephone progress which has hitherto distinguished Norway being arrested by the formulation of rules not adapted for the wants of particular localities. The Defence Association also considered it probable that the State would not be able to manage so economically as the various companies do, and that an increase on the very moderate existing rates would be found indispensable.

The justice of this view was borne out by a proposal which had been made by the friends of State acquisition as soon as the report of the committee had become known, that the telephone subscription in Christiania which for many years past has been £4 8s. 11d. and has proved sufficient, as I have already stated, to return 5½ per cent. dividends regularly, should be increased to £5 11s. 1d.

The Defence Association adopted the minority report, and recommended that the local exchanges and the short trunk lines should be left in the hands of their present owners while the State should acquire the longer trunk lines which more nearly approximate to the character of telegraph lines. For two sessions no action was taken on the report of the committee, the number of the advocates of State acquisition being estimated at only about 20 per cent. of the members of Parliament, but just before the conclusion of the last session, in July, 1895, the permanent Parliamentary Committee which controls the posts, telegraphs and railways (which permanent committee consists of 15 members of Parliament) recommended that the Government should adopt the minority report of the original Committee, and thereupon the Ministry decided that the Government should acquire the longer trunk lines only, leaving the local exchanges and shorter trunk lines, as they are at present, in the hands of municipalities and private companies.

Private or municipal enterprise has, therefore, been definitely left in Norway to deal with the telephonic question, and from the energy and technical skill which the Norwegian telephone engineers have exhibited in the past there can be no doubt of the result; and it may be assumed that Norway will continue to develop her telephonic system to an extent of which most people in this country have no sort of conception.

There can be little doubt that State Telegraph Departments are not the best managers of telephonic facilities. In my paper read before the British Association at their recent Ipswich meeting I gave many statistics and particulars on the progress of telephony in the chief European countries, from which it appeared that the greatest development and the lowest rates, together with the most liberal concessions to the public, are coincident not with Government control but with private enterprise. This view of the case has, since the meeting at Ipswich, been confirmed independently in a very singular manner.

You have before you two maps, one of Jutland in the Kingdom of Denmark, and the other of the province of Schleswig-Holstein in the Empire of Germany, immediately to the south of Jutland. You will perceive that Jutland is covered by telephone exchanges, there being scarcely a village not possessing one, while trunk lines, shown in red, on the map, connect all these together, and cover the country with a very network of wires. If you look now at the map of Schleswig-Holstein you will see that there are scarcely more than a half-a-dozen telephone exchanges, while the trunk lines consist of one route running north and south from Flensburg through Kiel to Altona, with a branch to Rendsburg.

The Chamber of Commerce of Flensburg, one of the chief towns of Schleswig-Holstein, has recently forwarded copies of these maps to the Imperial Government in Berlin, pointing out to the Government what I am now pointing out to you, that in Jutland, where telephonic enterprise is entirely in the hands of private companies, the country is covered with telephonic exchanges and telephonic trunk lines; that subscribers there are never charged more than £4 3s. 4d. per annum, while in the majority of cases the charges do not exceed from £2 10s. to £3 10s. per annum. But in Schleswig-Holstein, south of the Danish frontier, the telephone system is in the hands of the Imperial German Post Office, with the result that, although the country is much richer and better populated than Jutland, telephone exchanges are few in number, possess few subscribers, and are infinitely worse off than the Danish in respect to trunk line communication, while the annual charges are never less than £7 10s. per annum. The Flensburg Chamber of Commerce present these facts to the Imperial Government and petition that measures may be taken to improve the development of telephones in Schleswig-Holstein, and especially that the present excessive charges should be reduced, pointing out that the social and physical conditions of Schleswig-Holstein are practically the same as those of Jutland, and if the rates of between £2 10s. and £3 10s. are remunerative in Jutland, they should be made equally so in Schleswig-Holstein. With the petition was forwarded a list of some of the Danish companies, giving particulars of their capital, number of subscribers, and dividends, from which it appears that the last range from 5 per cent. to 16 per cent. A more apposite and striking example of the differences between the management of Government departments and the results which follow the application of local intelligence, skill, and the employment of local capital, it would scarcely be possible to find, for only a few years ago Schleswig-Holstein belonged to the Kingdom of Denmark, and was practically what it still is geographically, a part of the peninsula of Jutland. Had it remained Danish, Schleswig-Holstein would doubtless be to-day as well telephoned as Jutland is, for private enterprise would not then have been throttled by Government monopoly.

The German Telegraph Department is a highly organised concern, but it suffers from over-centralisation. The head-quarters are in Berlin and nothing can be done, however trivial, in any town or village in Schleswig-Holstein or any other part of the vast territory controlled by the Department, without previous consultation with, and permission obtained from Berlin. Local conditions are ignored, and the smaller towns and villages can only obtain telephonic facilities by guaranteeing the Post Office, over whose management they have no control, against loss.

It must not be supposed that low rates are peculiar to Norway. Of the 31 exchanges in Holland, all but three enjoy rates ranging from £4 19s. 1½d. per annum down to £2 9s. 7d. per annum, and these rates have proved remunerative to the undertakers. Sweden, Denmark, Switzerland, Luxemburg, and Finland, afford additional examples of cheap telephony.

But what experience have we in this country calculated to show that these low rates are as practicable here as on the continent? A good deal if we examine the history of the last fifteen years.

The rate of the Dundee and District Telephone Company was £5 10s. per annum for any distance, and it paid an average dividend of 9 per cent. during the four and a quarter years of its existence. To buy it out the National had to return its capital with 40 per cent. added, besides paying bonuses to the chief officials. The cost of the lines erected by the company was £15 each. The Sheffield Telephone Company paid good dividends for many years on a £7 rate. The Sheffield people still enjoy better terms than the other large towns, since when the National Company acquired their system they were enabled by threatening to call in an opposition company to stipulate for a special tariff which is still in force. The tariff is as follows:—

	Per annum.
For distances not exceeding 1½ miles	£8 0
For distances not exceeding 2 miles...	10 0
For each additional half mile beyond 2 miles ...	2 10
For private houses not exceeding 2 miles	7 0

These are much lower terms than those current in Manchester, Liverpool, or Glasgow, yet, as they exist, we may be sure that they are remunerative.

The Globe Telephone Company, which commenced an opposition exchange in London at £10, was bought over at an early stage in order that the monopoly rate of £20 might be maintained; the same fate subsequently overtook the New Telephone Company, which obtained 3,600 subscribers in London at a £12 12s. rate. Such an enterprise would have been fatal to the National Company's London exchange, and had to be bought up regardless of cost.

But the best and most recent example occurred in your own city of Manchester, where the Mutual Telephone Company constructed an exchange in 1891 at rates which varied from £5 for shareholders in the Company to £6 for non-shareholders. The Mutual Company introduced many improvements, and gave a service which was, I believe, unanimously regarded as much superior to that of its rival. The cost of connecting the Mutual subscribers by double wires was £16 16s. each; the average subscription, after deducting 10 per cent. for Post Office royalty, was only £4 12s. 2d. per line, a figure which approximates closely to the average receipts in Christiania; and yet after putting aside 5 per cent. on the capital expended for deterioration, paying directors' fees, and all working expenses, sufficient surplus was left to pay a dividend, had it been so desired, of 2·29 per cent. per annum. This was in the third half-year of the exchange's existence; subsequently the revenue increased rapidly, and with it the profit. At one time the Mutual Company had 1,389 lines working, but such a formidable rival could not be tolerated. The National Company got possession and the exchange will shortly be a thing of the past, although about 1,000 lines are still connected to it. Soon those subscribers who for the last five years have been paying from £4 to £6 for a good service will be called upon to pay £10 per annum, or go without telephonic communication.

There is only one other aspect of the situation to which I shall call attention before concluding. It is the woful effect which the existing monopoly is having upon our electrical industry. Abroad, immense quantities of telephonic apparatus are required to meet the rush of subscribers, and everywhere in France, Germany, Belgium, Switzerland, Sweden, Norway, we find extensive factories already in existence which are devoted entirely to the production of telephonic switchboards and apparatus, and more are continually coming into being. At Christiania I was shown a large building, still incomplete, which is being erected to meet the rapid extension of the Norske Elektrisk Bureau's telephonic business. We have nothing of the kind in this country. Why? Because all important orders for instruments and switching apparatus are, and always have been, placed abroad, principally in America, and as a consequence no development of a British telephonic instrument industry has been

possible. It is true that the Mutual Telephone Company used practically nothing but British-made apparatus, not because it was British only, but because it was of better design and better construction; but that was only a small indication of what would occur if telephones were free. Let those who have had experience of the rival systems in Manchester say which has given the most satisfaction—that of the National Company, whose apparatus is exclusively American, or that of the Mutual Company whose apparatus was nearly exclusively British. The suppression of the existing monopoly in telephone exchanges would not only give the subscribers reduced rates and better service, but would practically create a new home manufacturing industry, for the prejudices which at present divert the orders for apparatus into foreign channels would not, it is to be hoped, hold sway with municipalities, or with many competing companies.

Furthermore, the freeing of the telephone industry would provide an outlet for much of the surplus capital of the nation which is now locked up for want of legitimate fields for employment, or, what is worse, is lent to unstable foreign states, or devoted to the development of foreign countries. Much has been heard lately of the absolute necessity of opening up new markets in Africa and elsewhere; but we have at hand a means of employing at least some of our surplus capital at a profit; of finding work for thousands of electricians, of artisans, of clerks, and of labourers; of, in fact, as I have already stated, creating a new and extensive home industry. That means is the reversal of the existing policy of telephonic monopoly.

THE ARC LIGHT.*

By Prof. SILVANUS P. THOMPSON, D.Sc., F.R.S.

Lecture II.—Delivered January 21st, 1895.

(*Continued from page* 620.)

Trotter's Theory of Distribution.

In the spring of 1892, Mr. Alexander P. Trotter, who has done so much in arc lamp optics and physics, showed a much simpler way of treating the matter. He started from the physical standpoint at which I explained in my first lecture I arrived in 1889, viz., that because the arc is a phenomenon due to the volatilisation of carbon, it will have a definite temperature, and, therefore, assuming that temperature to be definite and the carbon to be pure, the light emitted at the crater surface will have a definite whiteness. Starting from that point he argued as follows:—It does not matter for optical purposes whether the crater is actually flat, or whether it is literally of a cup shape, since a luminous surface gives out only as much light in any direction as would be given out by a flat surface of equal intrinsic luminosity having exactly the same outline. This may seem a little strange, because it is contrary to one's experience of surfaces that are not self-illuminating. Take, for instance, an ordinary white saucer illuminated by the sky, or by artificial light. If you set that saucer up in any one particular position, and enquire how much light it throws to your eye as you move round it in different directions, you will find as matter of measurement that the amount of light given out in different directions does not depend simply on the visible size of that saucer, but owing to the circumstance that it receives its light at a particular angle and reflects it, the amount of light given out to your eye by any visible area of its surface depends upon the angle at which you see it. But where you are dealing with a self-luminous surface, this is no longer true. For instance, take a piece of white paper as a sort of model, imagine it to be a white hot surface. Look at it through any definite aperture—for instance, through this tube; you will see a round luminous disc (of a certain size, limited by the aperture). It will not make 1 per cent. difference whether the white surface behind it is absolutely square across, or whether it is turned or tilted obliquely. As long as there is enough white surface behind to extend completely across the visible aperture, the aperture will look equally bright. The angle of incidence to the sloping surface behind the aperture has nothing to do with the brightness. The self-luminous surface is equally bright whether it slopes or whether it stands squarely opposite to the eye. The crater surface may therefore, for optical purposes, be considered to act as a small white hot horizontal disc.

The amount of light that it will emit in any given direction will depend simply, in the first place, on the intrinsic brightness, and, secondly, on the visible area which it presents when viewed in that direction. The more obliquely it is viewed the less is the visible area. The amount of light ought to be strictly proportional to the apparent area as viewed in the direction in question. Mr. Trotter's first point, then, is that the crater, no matter what the actual hollow may be, may be treated as a flat disc suspended somehow or other up in the air, and shining white hot. Then what will be the geometrical distribution of light in all directions from this disc? That will be simply a matter of angle, or, rather, of the cosine of the angle. The disc will appear biggest, at any given distance away, if the eye is placed exactly opposite it. Because when the disc is square across the line of sight, it obviously will subtend the greatest apparent angle in space. It will appear of no size at all in directions at right angles to this, because the disc is edgeways, and the edge has no visible magnitude quantity. There will be no light in that direction; in other directions there will be some light. There will be a maximum in the direction of the normal to the surface; and the amount in any other direction will be simply proportional to the cosine of the angle which that direction makes with the normal. If you take the cosine of the angle as measured from the normal, or the sine of the angle as measured from the horizontal plane, and plot out the values in a polar diagram, as in fig. 16 below, you will find the points all lie on a semi-circle. In brief, cosines plotted as a polar curve give geometrically a circle that passes through the pole. Therefore, if this law were to be literally fulfilled, and if our crater were a horizontal disc up in the air—

Fig. 15.

whether circular in outline or not is immaterial—the amount of light measured in different directions, provided there were nothing to interefere, would plot out simply on a semicircle, giving us the diameter of the semicircle as the greatest amount of light measured down underneath the disc. Unfortunately, the arc lamp consists of something more than a top carbon with a level crater at the end of it. There is that unavoidable negative peak which gives out very little light of its own, which is merely being roasted in the heat of the crater above it, and which casts a shadow. If you will measure the

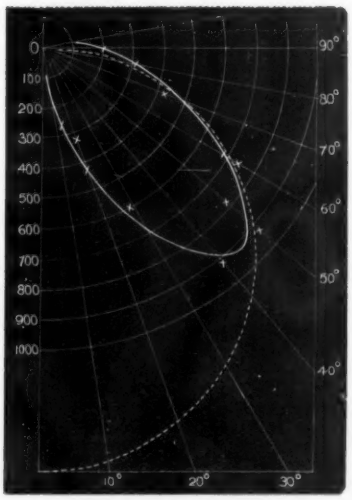


Fig. 16.

amount of the eclipse that goes on in different directions, you will get a measure of the amount of light cut off in those directions from the amount that would be strictly proportional to the cosine of the angle. No sooner had Mr. Trotter conceived this idea, than he was good enough to come and talk it over with me at the Technical College. I put one of my senior students, Mr. C. F. Higgins, at his disposal to devise a little piece of apparatus to test this theory. Mr. Higgins constructed the apparatus used by Mr. Trotter in the investigations which followed. I have the apparatus here (fig. 15) fixed on one of the Planet Company's lamps. There is attached to the frame-

* Cantor Lectures. From the *Journal of the Society of Arts*. References to this series of Cantor lectures will be found in the Electrical Review for January 18th and 25th, and February 1st, 1895.

work of the lamp the small apparatus by means of which the light given out from the arc in any direction can be examined. A lens is placed opposite the arc at a certain distance away, the light from that lens is received on a small mirror, having its front face metallised. The mirror being set at 45°, sends out the light at right angles, to a distant screen, where the image is received. Then by merely tilting to any desired angle the frame which carries lens and mirror, one can examine, in any direction within wide limits, the visible appearance as presented in that direction. Armed with this instrument one can make photometric measurements of the light sent out at different angles, without moving either lamp or photometer. But of more importance is the fact that by focussing the images on the screen, one can make pictures of the visible forms of the carbons. Putting a sheet of white paper against the screen you project on it any particular view of the arc you like, and then with a drawing pencil outline the proj ction on the paper. Having in this way obtained a series of sketches of the arc as projected at various known angles (and all on the same scale) you may then go over each sketch with a planimeter, and measure up the amount of luminous surface that is visible in different directions.

This elegant method of determining the illuminating effect at different angles is a feature of Mr. Trotter's investigation.* In his paper Mr. Trotter gives his results plotted out in the form of curves. In one curve he plotted the intensity of the light as measured in different directions. In another curve he plotted the amount of visible crater area, as measured in the different directions. So close is the agreement, that the curves are scarcely to be discriminated one from the other. Fig. 16 gives the curve of visible areas plotted as a polar diagram. The dotted semicircle gives the values of the cosines, which are proportional to the area of crater surface which would be visible if it behaved exactly as a disc, and had no obstruction in front. The light in any given direction is apparently proportioned to the amount of visible crater area exposed in that direction. This is a very important result, because it enables us to see exactly why the light is distributed as it is. Before Mr. Trotter's experiments there had, however, been some other observations made, dealing with the relation between the amount of light and the amount of current.

Intrinsic Luminosity of the Crater.

Let us proceed to correlate Mr. Trotter's observations on the relation between the amount of light and the crater surface with those earlier observations on the relation between the crater surface and the current.

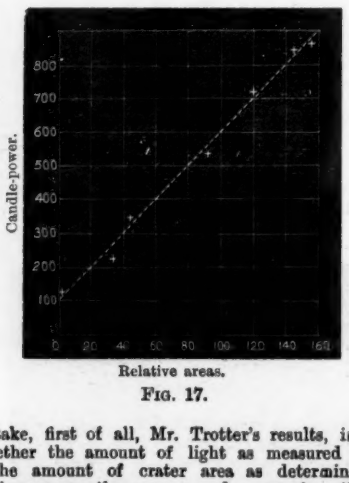


Fig. 17.

We will take, first of all, Mr. Trotter's results, in which we compare together the amount of light as measured photometrically, and the amount of crater area as determined by projecting the images on the screen, and measuring them with a planimeter. Fig 17 gives in graphic form the result of Mr. Trotter's researches on the relation between the candle-power of the arc and the visible area of the crater surface. The candle-power is plotted out vertically, and the corresponding areas of crater surface are plotted out horizontally; they lie practically on a straight line. The main thing substantiated is that, taking a certain datum line horizontally across the diagram at about 100 candles, any amount of light above that datum line is exactly proportional to the amount of area of crater surface. Then what is the meaning of having this datum line above the actual zero of candle-power? It means this, that all the light below that line drawn at about 100 candles, was due to other parts than the crater. That is to say, the total amount of light given out by the negative peak, by the duller red hot regions around the peak, and around the rim of the crater, and by the flame of the arc, amounted to about 100 candles. If we, then, discount this extra light which strays in from the other parts, we may say that the light given out is strictly proportional to the area of the crater surface. The other result I wished to correlate with this was an observation of Mr. J. D. F. Andrews on the relation between the crater area and the current going through the lamp. This research dates from 1880, before we began to talk about ampères of current, and when we talked about webers. Andrews's researches were on the number of webers of current going through a searchlight, and the amount of crater area as measured in the following way. After the lamp has been allowed to burn steadily for a given time, the current was stopped, and the carbons taken out. The size of the crater was measured up, and from that the area of crater surface was calculated. The observations plotted together, as in fig. 18, give a straight line which goes right down to zero. The current in these experiments was found to be rigidly proportional to the actual area of the crater. Consequently it follows, from Mr. Trotter's results, that the amount of light given out by a lamp (in any given direction) is also proportional to the current passing through that lamp.

If, then, the light emitted is simply proportional to the effective crater area, it ought to be possible to set down in definite terms the specific luminosity of the arc crater as so many units of light per unit of area. Many years ago, Mr. Hiram Maxim had arrived, I know not by what process, at a similar conclusion. He gave the rough-and-ready rule that you can calculate the total candle-power of a lamp by measuring the diameter of the crater in hundredths of an inch, squaring the number, and then multiplying by 10. This is equivalent to 127,000 candles per square inch, or approximately 200 candles per square millimetre—a figure which is high compared with those of other observers. Abney's values range from 39 to 116; Andrews's from 64 to 170; Trotter's from 80 to 170: while Blondel's

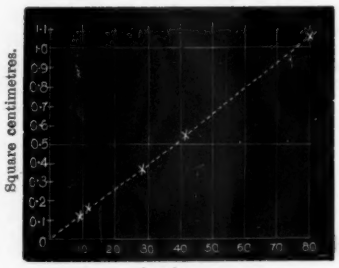


Fig. 18.

value is 160. The number of ampères per square millimetre of crater surface is about 0·78; so that the number of candles per ampère should be over 200. Palaz gives 204 to 240 in the direction of maximum brightness.

It will not, however, do to jump to the conclusion that because the crater area, and, therefore, the total quantity of light emitted, is proportionnl to current, that doubling the current in any given arc lamp will exactly double the light that that lamp gives out. For, if the current used at first is appropriate for the carbons of the size employed, a double current will be much too great to produce a proper crater, and the pencils will overheat. Moreover, the distance between the tips and the form of the tips will differ, and the distribution of the light will be different, preventing a fair comparison. Palaz gives the empirical rule that for a given lamp and carbons working between 40 and 50 volts, the number of candles ("bougies decimales"), *if measured in the direction of maximum brightness*, is equal to 200 $C + C^2$, where C is the current expressed in ampères. According to this, a 10-ampère current would give 2,400 candles in the maximum direction, while one ampère would only give 204. (The mean hemispherical brightness is only about two-thirds of the maximum.)

[*Note added, October*, 1895.—Shortly after the delivery of this lecture, Mrs. Ayrton published in the *Electrician* the results of her measurements of the crater, from which it appears that the current is not exactly proportional to the area of the crater, nor yet to its diameter, but to some power of the diameter between 1 and 2. On examining the curves on which her formula is based, it seems evident that further experiments are needed before the approximate law that the area of the crater is proportional to the current can be condemned.—S.P.T.]

Energy Spent in the Arc.

Before passing away from the relations established above, let us pause for a moment to consider the energy question. You may sometimes find it said, and it is perfectly true when you are dealing with a fixed resistance, that the energy spent by a current is proportional to the square of the current. That is, in fact, Joule's well-known law. If you double the current through a given resistance, the amount of energy you have to spend is fourfold; and if you were heating carbon you would perhaps argue that the light would be fourfold. But here we are confronted with the fact that, whatever the law might be supposed to be, when the current is doubled the light is doubled, not quadrupled. The light does not go by the square of the current. There is no paradox or puzzle in the circumstance, if one has once realised that important point developed in the former lecture, that the resistance of the arc is by no means a constant; that if you treat the arc as possessing a resistance, simply then you must say the apparent resistance of the arc for a given length varies inversely as the current. When you double your current, the resistance of your arc becomes halved. If, however, you treat the problem in the other way (which seems more rational), as involving the consideration of a back electromotive force, seeing that the back electromotive force is a nearly constant quantity, you must calculate the work done in another way, namely, as work done in driving a current against the opposing electromotive force. There would, in fact, be no work done at the crater surface if there was not located there something in the nature of back electromotive force. To put the thing in simple mathematical form:—If v represents the number of volts against which you are driving the current (*i.e.*, the true back electromotive force of the arc), and c stands for the number

* *Journal Inst. Elec. Engs.*, 1892, xxi., 360.

of ampères of current, then the work done per second is the product of those two. If we were dealing with a constant resistance, v itself would be proportional to the current; hence the product of the current into v brings the current twice over into the expression for the work done. Where, however, we are not dealing with a constant resistance, there being a fixed voltage to do work against, we must use the law in this shape just given: the work done in driving a current against a back electromotive force is the product of the two. If the voltage against which you are working is a constant, it follows that the power expended is proportional simply to the current, not to its square, a conclusion which is justified by the fact, that the amount of light given out is proportional also to the current, other things being equal.

Influence of Crater in Efficiency of Lighting.

Mr. Trotter's admirable paper deals, amongst many other things, with one very interesting practical point. Some years ago it was proposed by Sir James Douglass—a name so well known in connection with lighthouse work—to employ, for lighthouse illumination and projector lamps, a form of carbon rod, different from that which had been previously used. If I am rightly informed, the old carbons originally used in the lighthouses in Dungeness and elsewhere were made from battery-carbon or retort-carbon, sawn into square sticks about a quarter of an inch each way. They were afterwards replaced by round rods of somewhat larger diameter, and, for very powerful lights, by still larger rods. Sir James Douglass seems to have thought he would obtain a better light, a more central, steady, luminous patch to project through his lenses if he could avoid the wandering of the arc over the large surface of the crater. The wandering of the arc, when the carbons are too thick in proportion to the current used, is one of the things familiar to all who work with arc lamps. If you employ a larger size of carbon rod than is necessary for the size of the crater, that is, proportionally to the current, the crater will not be fully filled with light, but a luminous spot of the light will wander round and round unsteadily in the crater. Then at irregular intervals the crater wall will give way, sometimes on one side, and sometimes on the other, and you have loud hissing and extreme unsteadiness. It occurred to Sir James Douglass that if he fluted his carbons he would obviate the formation of a crater rim; he would, instead, obtain a crater with an edge consisting of points at regular intervals with spaces between, and presumably a more steady arc. Mr. Meyer has sent me these two specimens of Sir James Douglass's lighthouse carbons. They look to me as if they were taken from an alternating current lamp. Neither of them has a well-formed crater. There is here a second pair of fluted carbons, intended for a smaller lamp, which have the same peculiarity. Mr. Trotter examined the arcs made by using fluted carbons, and reading between the lines, I judge that he was not favourably impressed with the arc produced under those conditions. The fact is, if you want a good light, you must have a good crater. This I take to be the explanation of the attempt to improve carbons by coring them; that is, by making them tubular, and filling the bore with carbon of a softer quality. This device appears to have a beneficial effect in anchoring the arc, and preventing it from wandering round the crater, by giving it a kind of foothold. The soft core tends, in fact, to promote the formation of a crater, and, consequently, to steady the arc. With very short arcs, and arcs that hiss, the crater is generally very irregularly formed, and much deeper as a cup, than is the case in the long arcs. The mushroom growth that is observed with hissing or short arcs is formed at the expense, in fact, of material torn up from the bottom of the crater. This is but one of a number of irregular phenomena which really need not engage us further, but must, however, be taken into account in any complete account of the optics of the arc. The rapid changes of colour in the flame, whenever the arc is in an unstable state, are very curious.

Whiteness of the Arc Light.

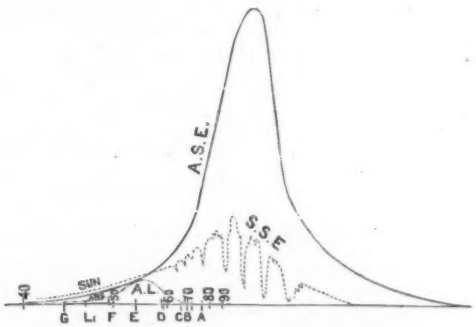
Another very important point in the optics of the arc is its constant degree of whiteness. It was found by Captain Abney long ago, in 1878 or 1879, I think, that the relative amounts of the radiation of different colours—red, blue, yellow, and so forth—in the arc light are always the same, other things being equal; the arc is, in fact, of a constant degree of whiteness, so much so, that for years he has used it as a standard of comparison in his researches on colour photometry. This constant degree of whiteness, so far as it is true, is evidence of constant temperature, or possibly of constant temperature coupled with constant emissivity. It is a curious point that when the arc wanders from spot to spot, in the rapid fluctuations that sometimes occur—about which I shall have something to say presently—the apparent whiteness of the arc remains the same, although the intensity of it may vary, that is to say, one patch may look whiter than another patch by having more light coming from it, yet you do not get a change of colour. You cannot say that it is any redder, any greener, or any bluer, there is simply more light coming from it; so that it appears that there may be something comparable to constant temperature, and yet different emissivities at portions of the same surface.

So three years ago, Mr. Swinburne and I, independently, suggested that, seeing the arc is always (or was supposed to be always) of a constant degree of whiteness, the very best standard of white light would be that of a fixed area or patch selected from the crater of the arc (by means of a diaphragm having a very small hole in it). We could desire no more perfect standard of white light than one always equally white and of a fixed size. This suggestion of using a square millimetre, let us say, of incandescent carbon at arc temperature, as the standard of white light, was a very fascinating one. I did my best to have it taken up in Germany by the late Prof. Von Helmholtz. The last letter I ever had from him was on this subject. The suggestion has been put to trial both by Mr. Trotter, in London, and by M. Blondel, in Paris. The result of it all is that, fascinating as the idea may be, it will not do; not only are there inherent difficulties at the very high temperature that prevails in getting the light through the small diaphragm placed close up to the arc, but, as Mr. Trotter has found, the variations of the light are so extraordinary that at present it seems unlikely that we shall ever in this way attain a true standard of invariable amount.

What, then, are these variations about which I am speaking? In the first place, if the carbon contains impurities, the light is of lower intrinsic brightness. The soft variety of carbon used as a core in the cored carbons shows as a duller patch at that part of the crater. As an experiment, I had an arc light carbon cut down lengthways; there was fixed up against it a pencil made from the best graphite one could get—a pure natural graphite. This combination was, in fact, a carbon rod, half of which was ordinary arc light carbon, and half of which was plumbago. Using this compound rod as a top carbon, I found the crater to be unequally illuminated over the two halves. The supposed pure graphite shone less brightly; it was white; but it shone with a different amount of light from the patch of ordinary arc light carbon, just as the cores of the cored carbon pencils shone with a different degree of brightness. In using cored carbons you, in fact, sacrifice a little of the candle-power in order to obtain steadiness. It is a not unimportant fact that impurities lower either the temperature or the emissivity of the surface, and the result is a want of standard condition. The more recent discovery of Mr. Trotter—presently to be described—is much more upsetting.

Luminous and Non-Luminous Energy.

The energy that is given out by surface light is, unfortunately, not given out only as light. There is other energy of a non-luminous kind. I am not exaggerating when I say that only about one-twentieth or one-twenty-fifth of the energy supplied to the arc, and emitted at the crater, is effective in producing illumination. To put it in a popular way, for every ray of visible light you have given out, you have 24 or 25 rays of invisible light; that is to say, of heat; so that the luminous efficiency of the arc is something like 4 or 5 per cent. only. Of the energy spent, there is only some 4 or 5 per cent. which is effective in producing illumination. Here is a diagram intended to illustrate that. Using a proper kind of prism to disperse the rays, one may produce a spectrum. Such a spectrum has been given by various authorities: Müller, Tyndall, Abney, and Langley.* From the recent researches of the three last named I have prepared the diagram (fig. 19), in which different rays of luminous and non-luminous light are supposed to be plotted out before you. In this



A S E, Arc spectrum energy; S S E, Sun spectrum energy; A L, Arc luminosity.

Fig. 19.

case, the luminous spectrum occupies a very small part of the diagram. The smallest of the three curves is Captain Abney's curve of relative luminosity or sensitiveness of the normal eye to different kinds of light. The eye is most sensitive to light in the yellow or greenish yellow, and least sensitive to the red, and to blue and violet. What proportion do these radiations to which the eye is sensitive, and which are effective, therefore, for the purpose of illumination, bear to the whole amount of radiation? Only this very small area underneath that curve of luminous energy, as compared with the area underneath the tall black curve, which represents the spectrum of the total emission of visible and invisible rays from the arc. Right away down in the *infra* red you have this enormous development of waves of slow period—heat waves in fact. They are given out in far greater abundance than the waves which affect the eye as luminous waves. The ragged curve which is intermediate between the others, represents to the same scale as the arc spectrum, a spectrum for an equal amount of light, if derived from the sun. It shows how waves of a certain length are absorbed off by the intermediate atmosphere between us and the sun. This curve is taken from Langley. One of the things we have to look forward to in the development of artificial light is the production of lamps which shall be of a higher efficiency than the arc lamp. They must, for an equal amount of energy supplied to them, emit a far greater percentage of waves of a length that will affect the eye as luminous waves, and a far less percentage of those longer waves which do not help the illumination, but which only warm us. Such a transformation has been wrought for gas lighting in recent years in the introduction of Dr. Auer's incandescent

* Langley, "Researches on Solar Heat" (Washington, 1884), plate xi.

mantle. He discovered a material whose emissivity, at the temperature of the gas flame, is higher than that of the carbonaceous matters in the ordinary flame of coal gas; it emits a greater percentage of wages of the sorts that affect the eye, and a lesser percentage of the non-luminous waves. The vacuum tube lamps, and their modern varieties, such as Tesla's lamps and Ebert's luminescence lamp, are attempts to procure a better specific luminescence from a given amount of energy.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free*, 8½*d. (in stamps)*]

NEW PATENTS.—1895.

20,790. "Improvements relating to filaments for electric incandescent lamps." F. E. W. Bowen. Dated November 4th.

20,801. "An improved means for electrically lighting gas jets from a distance." O. von Morstein. Dated November 4th.

20,807. "Process for the production of electrotypes or galvanos with engraved or sunk drawings or designs." R. Mayer. Dated November 4th.

20,815. "Improvements in coin released machines which are electrically driven." E. T. Middlemiss. Dated November 4th.

20,821. An improved reflector for electric arc lamps." V. Fabris. Dated November 4th.

20,824. "Improvements in or relating to electric batteries." W. Grimes. Dated November 4th.

20,828. "Improvements in or relating to primary electric batteries." W. Rowbotham. Dated November 4th.

20,835. "Improvements in or relating to insulating conduits or tubing and connecting boxes for containing electrical conductors." A. J. P. Whitaker, and F. G. Treharne. Dated November 4th.

20,843. "Improvements in electric batteries." C. P. Shrewsbury, F. L. Marshall, and J. L. Dobell. Dated November 5th.

20,883. "Improvements in electric systems." P. M. Justice. (W. H. Nixon, United States). Dated November 5th.

20,904. "Improvements in controlling electric motors by the three-wire system." J. Devonshire. (W. R. Potter, United States.) Dated November 5th.

20,905. "Improvements in electrically driven machinery." E. N. Bray. Dated November 5th.

20,917. "An improved form of electric candle fitting." E. Bulstrode. Dated November 5th.

20,923. "Improvements in electrical annunciators." W. P. Thompson. (H. B. Higgins, United States.) Dated November 5th.

20,924. "Improvements in electrical annunciators." W. P. Thompson. (H. B. Higgins, United States.) Dated November 5th.

20,925. "Improvements in batteries or compound bells applicable for pocket electric lamps and for other purposes." E. Burnet. Dated November 5th

20,926. "Improvements in block systems for electric railways." R. Belfield. Dated November 5th.

20,928. "Improved means and appliances for regulating the feed of carbons in electric arc lamps." J. Jeffryes and J. Lea. Dated November 5th.

20,940. "Improvements in printing telegraphs." J. Y. Johnson. (J. E. Woodbridge, United States.) Dated November 5th.

20,956. "Improvements in collecting brushes for dynamo electrical machines, electrical motors, and other electrical machines and apparatus." J. Lenderyon, Jun., and J. Williams, Jun. Dated November 6th.

21,045. "Controlling electrical switches." J. Browett and H. A. Henderson. Dated November 7th.

21,050. "Improvement on the preparation of hydrosulphite of sodium by the electric current." L. Marchlewski and M. Hertz. Dated November 7th.

21,090. "Improvements in or relating to welding or joining together metals by electricity." H. A. Bessemer. Dated November 7th.

21,137. "Electrical tramway and railway conductors." G. H. Nisbett. Dated November 8th.

21,146. "Improvements in the construction of tubes or conduits for electrical conductors." F. Bathurst and G. Binswanger. Dated November 8th.

21,153. "Improvements in or in connection with arc lamps." F. M. Lewis. Dated November 8th.

21,283. "Improvements in the electro-depositing of metals." A. S. Elmore. (J. O. S. Elmore, India.) Dated November 9th.

21,297. "Improvements in automatic electric arc lamps and automatic cut-outs." G. H. Church. Dated November 9th,

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

60. "An improvement in electric arc lamps." W. Stevens. Dated January 1st. Regulating mechanism. The upper carbon holder has a rack, which engages with a pinion loosely pivoted on a stud secured to a lever. This lever is pivoted at one end to a fixed bracket, and at the other end is supported by a spring, and has pivoted to it a brake lever and the iron core of a shunt coil. The brake lever carries a brake block which engages with a brake wheel fixed to the pinion, and also an adjustable stop pin adapted to engage with the bracket. While the current is turned off the carbons are separated by action of a spring, which lifts the lever, and thus brings the pin clear of the bracket. The brake therefore locks the wheel and pinion, hence the carbon holder is raised. As soon as the current is turned on, the shunt coil attracts the core and the lever is pulled down, the wheel is therefore released and the carbons come together; immediately this happens current is shut off from the shunt coil, so that the carbons are separated again and the arc is struck. As the arc grows longer, the shunt coil is energised and attracts its core, thus allowing the carbons to come together. A modification is described. 2 claims.

1,245. "Improvements in signalling on railways and means therefor." R. B. Annesley, E. Blakey, W. R. Sykes and J. P. O'Donnell. Dated January 18th. Refers to specification No. 9,930, of A.D. 1894. The object is to prevent the starting signal at A being lowered, after a train has passed into the section between A and B, until a treadle at the starting signal at B has been depressed by said train leaving the section. The train also upon entering the section between A and B depresses a treadle, which raises the A signal to the danger position. Hence there are two treadles at each signal. The ordinary lock-and-block signal instruments are also provided at A and B, so that the signal at A cannot be lowered except by sanction of the signalman at B. When such sanction has been given, however, the signalman at B can, by putting his instrument to "line blocked," restore the signal at A to the danger position, notwithstanding the fact that it has been lowered by A, at the same time notifying A that the sanction previously given has been revoked. 6 claims.

12,772. "Improvements in automatic safety devices for electric circuits." Dated July 2nd. Consists in placing upon an electric circuit, at the commencement of said circuit, a switch controlled by an electric device, preferably an electro-magnet, in shunt with the circuit, upon which is the switch, the resistances of the shunt circuit being greater than the resistance of the shunt of the line circuit under normal conditions; but if a wire breaks in the main circuit, the resistance becomes greater than the resistance of the shunt circuit, and the magnet is energised, so that it acts upon the switch to open the line or circuit at its commencement, so that the broken wire is no longer a live wire. 14 claims.

13,380. "Improved electric lighting system for railway vehicles and other purposes, and dynamo therefor." M. Moskowitz, L. D. Adler, A. S. Adler, and T. W. Myers. Dated July 11th. Refers to dynamos operated at a variable speed, for example, from a car wheel axle of a railway car. The dynamo has an ordinary exciting coil shunting the main circuit, a second differential coil shunting the first-named coil, and a third also differential coil in the main circuit. At the predetermined speed, the first shunt coil excites the dynamo, so that the potential is normal. If the speed increases, the high resistance second shunt coil cuts down the increased magnetism due to the increase of current in the first coil, and also the series coil acts, owing to the increase of the current, and further cuts down the magnetism. Hence, although the armature is rotating at a higher speed and the first shunt coil is over excited, the potential at the terminals remains normal. 7 claims.

13,388. "Improvements in electric arc lamps." J. Devonshire, E. Thomson, and C. E. Harthan. Dated July 11th. Relates to lamps for use upon constant potential or incandescent lighting circuits, and is especially useful where a single lamp is to be connected up in such a circuit. The lamp is applicable for use either with alternating or continuous coils. The entire regulation both in striking the arc and in regulating its length is obtained by means of a series coil, no shunt coils or contacts to be opened or closed being employed. 13 claims.

13,389. "Improvements in methods and means for regulating the speed of continuous current motors." J. Devonshire. (Communicated from M. J. Whiteman.) Dated July 11th. The motor is so devised that it can be operated either as a two-pole or a four-pole motor, the armature being in two halves, which are first joined in series and then in multiple. The controller is described arranged to join the circuits of the machine in various ways as desired. 10 claims.

13,416. "Improvements in electric lamps for stage lighting." A. Waltens. Dated July 12th. Relates to arc lamps especially adapted for use in place of the ordinary lime lights at the side of the stage. The carbons are horizontal, and the rearmost one has a reflector attached for sending the light in the required direction. The arc is struck, and the length thereof is regulated by hand. A small mirror is provided, by means of which the attendant causes the arc from the back in order to regulate it properly. 5 claims.

13,573. "Improvements in multiple switches for telephone exchanges." F. Stock. Dated July 15th. Refers to specification No. 6,171, of 1895, and consists in the arrangement or modification of the apparatus described therein such that the rising of the annunciator flaps is effected automatically, whereby the manipulation of the multiple switch devices is further facilitated and simplified, without the cost of construction being increased to any considerable extent. 5 claims.